132050

Middletown Airfield Site
Middletown, Pennsylvania

Supplemental Studies Investigation

Volume II - Appendices

1 July 1994

Appendix A
Quality Assurance Project Plan

FINAL
Quality Assurance Project Plan
Supplemental Studies Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Under Contract with
U.S. Army Corps of Engineers
215 N. 17th Street
Omaha, Nebraska 68102-4978

Prepared for:
Air Force Regional Compliance Office
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1 JULY 1994

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1.0 PROJECT DESCRIPTION

This deliverable is the Quality Assurance Project Plan (QAPP) for the Supplemental Studies Investigation at the Middletown Airfield NPL Site. This QAPP has been prepared according to the guidance specified in USACE "Engineering and Design Chemical Data Quality Management for Hazardous Remedial Activities", Regulation No. ER-1110-263, 1 October 1990.

This QAPP presents the sampling and analytical quality assurance (QA) and quality control (QC) measures that will be conducted during the investigation. This plan is an integral document to the investigation. A summary of the site location, environmental setting, facility history, and previous site studies is presented in Section 1.0 of the Work Plan.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

While all personnel involved in an investigation and in the generation of data are implicitly a part of the overall project and quality assurance program, certain individuals have specifically delegated responsibilities. The USACE Project Manager will be the primary USACE contact for the ERM-FAST investigation. Within ERM, these individuals are the Program Manager, Project Manager, the Data Management Administrator, the Project Safety Supervisor, the Quality Assurance Manager, the Quality Assurance Chemist/Laboratory Coordinator, the Field Operations Manager, and the Project Geologists and Technicians. Lancaster Laboratories, Incorporated, (LLI) of Lancaster, Pennsylvania and Mountain States Analytical, Incorporated (MSAI), of Salt Lake City, Utah will provide the analytical services for this investigation. LLI and MSAI will also provided accelerated turnaround analytical services for this project.

Specific laboratory personnel with QA/QC responsibilities include the Analytical Task Manager, the Quality Assurance Coordinator, and the Sample Management Officer. Responsibilities designated for these specific LLI and MSAI personnel are provided in this section.

A project organization chart is presented in Figure 2-1.

2.1 USACE PROJECT MANAGER

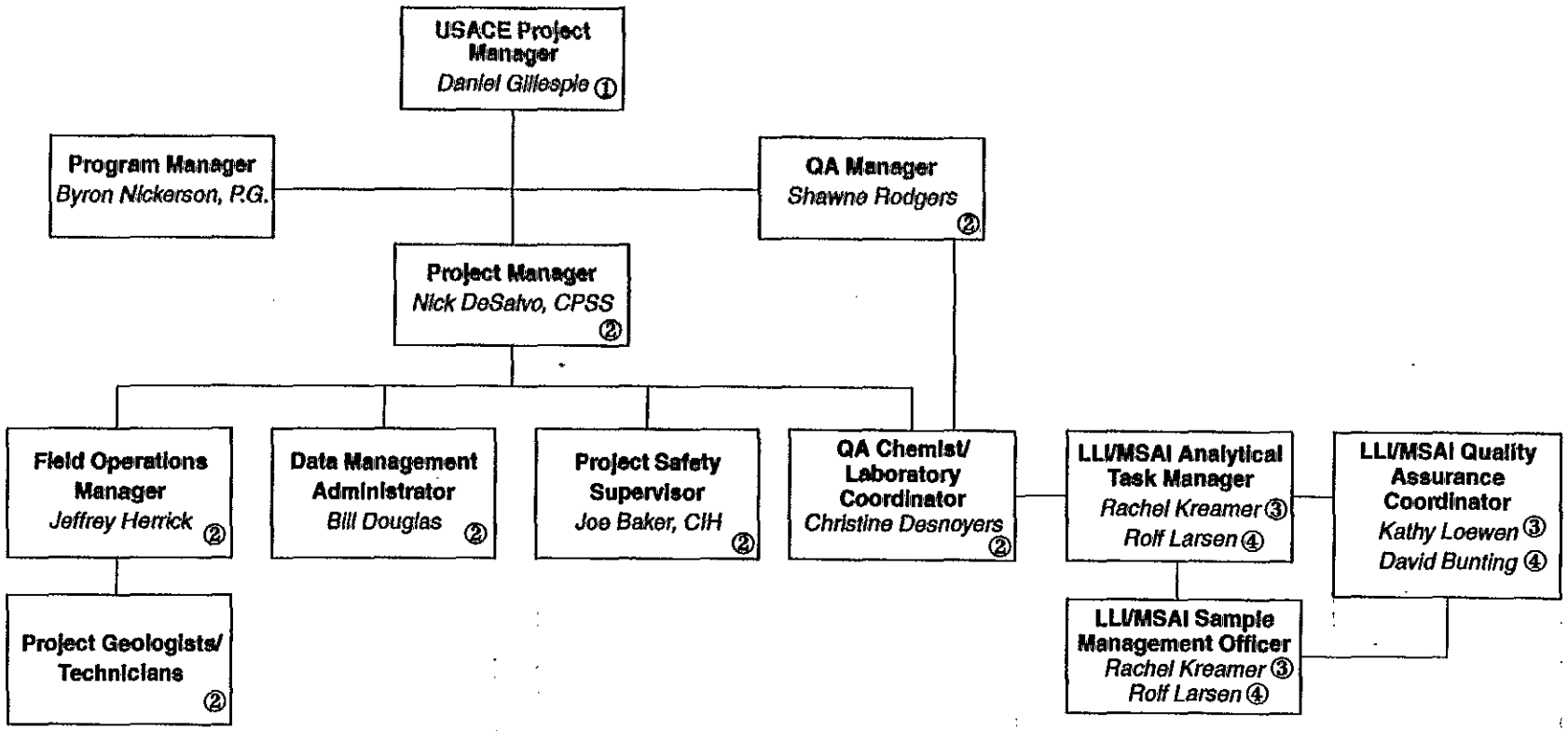
Mr. Daniel Gillespie will serve as the USACE Project Manager for the investigation. Mr. Gillespie will be the principal contact between USACE, ERM, LLI and MSAI for all facets of the investigation. His responsibilities will include, but are not limited to, implementing the USACE QA Program, forwarding review comments from the USACE Technical Branch to ERM, LLI, and MSAI, ensuring that LLI and MSAI has the required USACE certifications specified by the investigation, and serving as the liaison between ERM, LLI, MSAI, and USACE should any changes in the scope of the investigation occur.

2.2 ERM PROGRAM MANAGER

Mr. Byron Nickerson, P.G., is the Program Director for the investigation. He will provide senior level technical review for all aspects of the project.

ERM, INC

Figure 2-1
Project Organization Chart
Middletown Airfield NPL Site



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2.3 *ERM PROJECT MANAGER*

Mr. Nick DeSalvo, CPSS, is the Project Manager (PM) for the investigation. The PM is responsible for oversight and coordination of the various elements of the investigation.

The PM maintains routine contact with the progress of the investigation, regularly reviews the project schedule, and reviews all major work elements prior to submittal. The PM oversees all scheduling and budgeting for the investigation and serves as the prime contact with USACE.

2.4 *ERM DATA MANAGEMENT ADMINISTRATOR*

Mr. Bill Douglas is the Data Management Administrator for the investigation. Mr. Douglas is responsible for implementing the procedures and systems developed to support data management. He will also be responsible for the coordination of prime and subcontractor data management and tracking activities. This includes coordination with laboratories to resolve data errors and inconsistencies.

2.5 *ERM PROJECT SAFETY SUPERVISOR*

Mr. Joe Baker, CIH, is the Project Safety Supervisor for the investigation. He will approve all safety procedures and operations at the site and update equipment or procedures based on new information gathered during the site inspection. Mr. Baker is responsible for upgrading or downgrading the levels of personnel protection based upon site observations; downgrading will require the approval of the PM. Mr. Baker will also determine and post locations and routes to medical facilities, will notify site emergency officers of the nature of the team's operations, and make all emergency telephone numbers available to the field staff members.

2.6 *ERM PROJECT GEOLOGIST*

The Project Geologist will ensure that the various investigative functions of the site are carried out in a thorough and technically competent fashion.

2.7 *ERM QUALITY ASSURANCE MANAGER*

Ms. Shawne Rodgers serves as Quality Assurance Manager on all projects requiring the collection of data, and as such is not directly involved in the routine performance of technical aspects of the investigations.

The Quality Assurance Manager's responsibilities include the development, evaluation, and documentation of the QAPP and procedures appropriate to the investigation. Additional responsibilities include reviewing project plans and revising the plans to ensure proper quality assurance is maintained.

It is a major responsibility of the Quality Assurance Manager to ensure that all personnel have a good understanding of the project quality assurance plan, an understanding of their respective roles relative to one another, and an appreciation of the importance of the roles to the overall success of the program.

2.8 *ERM QUALITY ASSURANCE CHEMIST/LABORATORY COORDINATOR*

Ms. Christine Desnoyers will serve as the Project Quality Assurance Chemist/Laboratory Coordinator. The Quality Assurance Chemist/Laboratory Coordinator has primary responsibilities including coordinating communication between the project team and the subcontracted laboratory including scheduling analytical services and informing the laboratory of sample shipment and expected receipt dates; issuing the appropriate chain-of-custody and traffic report forms; and tracking, logging, and filing documentation returned from the laboratory. The Quality Assurance Chemist/Laboratory Coordinator will also be responsible for project data validation activities.

2.9 *ERM FIELD OPERATIONS MANAGER*

Mr. Jeffrey Herrick will serve as the Field Operations Manager (FOM) for this investigation. The FOM is responsible for all soil boring and well installation field tasks and for the day-to-day activities of all ERM field personnel. The FOM is responsible for all field quality assurance and all other non-analytical data quality review. Further responsibilities include the verification for accuracy of field notebooks, driller's logs, chain-of-custody records, sample labels, and all other field-related documentation.

2.10 *ERM PROJECT TECHNICIANS*

All sampling tasks required by this investigation will be conducted by experienced environmental geologists and technicians. Their responsibilities will include the documentation of the proper sample collection protocols, sample collection and field measurements, equipment decontamination, and chain-of-custody documentation.

2.11 *LLI AND MSAI LABORATORY ANALYTICAL TASK MANAGERS*

Ms. Rachel Kramer will serve as the LLI Laboratory Analytical Task Manager for the investigation. Mr. Rolf Larsen will serve as the MSAI Laboratory Analytical Task Manager. The Laboratory Analytical Task Manager will be responsible for implementing the USACE quality assurance program at the laboratory. The Laboratory Analytical Task Manager will be responsible for providing ample equipment, space, and resources such that the specified analyses can be conducted. The Laboratory Analytical Task Manager will also be responsible for providing USACE with the appropriate documentation and certification data and will serve as the primary contact for all subcontracted analytical work associated with the investigations. The Laboratory Analytical Task Manager will be responsible for ensuring the implementation of corrective actions, as required by the LLI Quality Assurance Coordinator.

2.12 *LLI AND MSAI QUALITY ASSURANCE COORDINATORS*

Ms. Kathleen Loewen will serve as the LLI Laboratory Quality Assurance Coordinator for the investigation. Mr. David Bunting will serve as the MSAI Laboratory Quality Assurance Coordinator. The Laboratory Quality Assurance Coordinator will be responsible for establishing, overseeing, and auditing specific procedures for documenting and controlling analytical data quality. The Laboratory Quality Assurance Coordinator will ensure that the analytical results are being interpreted correctly, ensure overall conformance with authorized laboratory policies and practices as well as with the USACE QA Plan, and recommend improvements. The Laboratory Quality Assurance Coordinator will inform the Analytical Task Manager of any laboratory nonconformance, as well as establish analytical lot sizes, and ensure that all environmental samples and laboratory control samples are designated to the correct lot size and sample number throughout all facets of the analytical procedures.

2.13 *LLI AND MSAI SAMPLE MANAGEMENT OFFICERS*

Ms. Rachel Kramer will serve as the LLI Sample Management Officer for the investigation. Mr. Rolf Larsen will serve as the MSAI Sample Management Officer. The Sample Management Officer will be responsible for preparing sample containers, preservatives, and shipment coolers. The Sample Management Officer will also be responsible for the receipt of the samples and will ensure proper sample entry and handling procedures are carried out by all laboratory personnel.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION ACCURACY, REPRESENTATIVENESS, COMPARABILITY, AND COMPLETENESS

3.1 OVERALL PROJECT OBJECTIVES

Data Quality Objectives (DQO) are quantitative and qualitative statements specifying the quality of the environmental data required to support the decision-making process. DQO define the total uncertainty in the data that is acceptable for each specific activity during the investigation. This uncertainty includes both sampling error and analytical error. Ideally, zero uncertainty is the intent; however, the variables inherently associated with the process (field and laboratory) contribute to uncertainty in the data. It is the overall objective of the investigation to keep the total uncertainty within an acceptable range that will not hinder the intended use of the data. In order to achieve this objective, data quality requirements such as quantitation limits, criteria for accuracy and precision, sample representativeness, data comparability, and data completeness have been specified to be used for the investigation report.

The overall project DQOs and requirements will be established such that there is a high degree of confidence in measurements performed during the project. Specific project DQOs are summarized in Table 3-1. The sample media that will be collected will be soil vapor, ground water, surface water, sediment, surficial soil, and subsurface soil.

As stated earlier, the parameters that will be used to specify data quality requirements and to evaluate the analytical system performance are precision, accuracy, representativeness, completeness, and comparability (PARCC). Table 3-2 presents the definitions for PARCC.

Table 3-1

Middletown Airfield NPL Site Supplemental Studies Investigation Data Quality Objectives

Area	Media	Type of Analysis	Purpose	Data Quality Level
Industrial Area - Pipeline	Soil Gas	On-site GC Analysis	To identify potential sampling locations.	II
	Surficial/Subsurface Soil	On-site GC Analysis	To aid in the placement of boreholes and sample selection.	II
		Off-site Analysis	To assess presence and vertical extent of constituents.	III
Industrial Area - Main Buildings Area	Surficial/Subsurface Soil	On-site GC Analysis	To aid in the placement of boreholes and sample selection.	II
		On-site GC/MS Analysis	To assess presence and vertical extent of constituents.	III
		Off-site Analysis	To assess presence and vertical extent of constituents.	III
		Geotechnical Testing	To develop geologic profiles and characterize physical properties.	NS
	Ground Water	Off-site Analysis	To assess presence and vertical extent of constituents.	III

Definitions of Data Quality Levels
Level II - Screening using portable instrumentation.
Level III - Laboratory analyses using non-CLP methodologies.
Level NS - Geotechnical/geophysical testing for physical properties of site media.

Table 3-1

Middletown Airfield NPL Site Supplemental Studies Investigation Data Quality Objectives

Area	Media	Type of Analysis	Purpose	Data Quality Level
Industrial Area - Pipelines to Lagoon and Waste Sump House	Surficial/Subsurface Soil	On-site GC Analysis	To aid in the placement of boreholes and sample selection.	II
		On-site GC/MS Analysis	To assess presence and vertical extent of constituents.	III
		Off-site Analysis	To assess presence and vertical extent of constituents.	III
		Geotechnical Testing	To develop geologic profiles and characterize physical properties.	NS
	Ground Water	Off-site Analysis	To assess presence and vertical extent of constituents.	III

Definitions of Data Quality Levels
Level II - Screening using portable instrumentation.
Level III - Laboratory analyses using non-CLP methodologies.
Level NS - Geotechnical/geophysical testing for physical properties of site media.

Table 3-1

Middletown Airfield NPL Site Supplemental Studies Investigation Data Quality Objectives

Area	Media	Type of Analysis	Purpose	Data Quality Level
North Base Landfill Area	Ground Water	On-site GC Analysis	To identify boundary of contaminant movement in ground water.	II
		Off-site Analysis	To confirm the on-site analysis results.	III
Main Airport/Industrial Storm Sewers	Sediment	Off-site Analysis	To assess presence levels of constituents	III
HIA Production Wells	Ground Water	Off site Analysis	To assess presence and depth specific of constituents	III
Meade Heights Area	Surface Water	Field Screening	For water quality parameters	II
		Off-site Analysis	To assess presence of constituents	III
	Sediment	Off-site Analysis	To assess presence of constituents.	III
		Geotechnical Testing	To develop geologic profiles and characterize physical properties.	NS
Susquehanna River	Surface Water	Field Screening	For water quality parameters.	II
		Off-site Analysis	To assess presence of constituents.	III
	Sediment	Off-site Analysis	To assess presence of constituents.	III
		Geotechnical Testing	To develop geologic profiles and characterize physical properties.	NS

Definitions of Data Quality Levels
Level II - Screening using portable instrumentation.
Level III - Laboratory analyses using non-CLP methodologies.
Level NS - Geotechnical/geophysical testing for physical properties of site media.

Table 3-1

Middletown Airfield NPL Site Supplemental Studies Investigation Data Quality Objectives

Area	Media	Type of Analysis	Purpose	Data Quality Level
Background	Surficial/Subsurface Soil	On-site GC Analysis	To aid in the selection of grab samples for analyses	II
		On-site GC/MS Analysis	To assess presence and vertical extent of constituents.	III
		Off-site Analysis	To assess presence of constituents	III
		Geotechnical Testing	To develop geologic profiles and characterize physical properties	NS
Ground Water Monitoring Program	Sample new and existing monitoring, production, and residenti wells.	Off-site Analysis	To assess presence of constituents.	III
SVE Pilot Test	Vapor	On-site GC Analysis	To evaluate the feasibility of this technique for reducing contamination at the site.	II
	Subsurface Soil	Off-site Analysis	To assess presence of constituents.	III

Definitions of Data Quality Levels
Level II - Screening using portable instrumentation.
Level III - Laboratory analyses using non-CLP methodologies.
Level NS - Geotechnical/geophysical testing for physical properties of site media.

Table 3-2 Definitions of Data Quality Parameters

Precision	A measure of the reproducibility of measurements under a given set of conditions.
Accuracy	A measure of the bias that exists in a measurement system.
Representativeness	The degree to which sample data accurately and precisely represent selected characteristics.
Completeness	A measure of the amount of valid data obtained from the measurement system compared to the amount that is required.
Comparability	A measure of confidence with which one data set can be compared with another.

3.2 *FIELD INVESTIGATION QUALITY OBJECTIVE*

The objective with respect to the field investigation is to maximize the confidence in the data in terms of PARCC.

Section 9.0 of this QAPP presents the frequency with which travel blanks, field duplicates (blind) and split quality assurance samples will be collected such that a specific degree of precision and accuracy can be calculated. The data quality objective for field QC check samples is to achieve precision or accuracy equal to or greater than that summarized in Table 3-3.

Field duplicate precision will be calculated as the relative percent difference (RPD) if there are only two analytical points, and as relative standard deviation (RSD) if there are more than two analytical points. The submission of trip blanks will provide a check on accuracy. Although accuracy is best assessed by evaluating the results of blanks, blanks do not monitor analyte losses. The submission of blanks will, however, monitor contaminants introduced with the sampling process, preservation, handling, shipping, and the analytical process. The data quality objective for these blanks is to have contaminant levels less than the quantitation limit (QL). In the event that the blanks are contaminated and/or poor field duplicate precision is obtained, a report will be written and given to the project manager who will in turn submit this with his reports to USACE (see Section 14.0). Through the submission of field QC samples, the distinction can be made between laboratory problems, sampling technique, and sample matrix variability.

Table 3-3 Criteria Objectives

Precision Objectives	Aqueous	Solid/Other
Field Duplicate/Replicates (Blind or labeled)/Split QA Samples		
TCL VOC	within 20% RPD	within 30% RPD
TCL BNA	within 25% RPD	within 40% RPD
TCL Pesticides/PCBs	within 25% RPD	within 40% RPD
TAL Inorganics	within 25% RPD	within 40% RPD
Miscellaneous Parameters	within 25% RPD	within 25% RPD
Laboratory Duplicates (Unspiked)		
TAL Inorganics	As specified in Attachment 1	As specified in Attachment 1
Miscellaneous Parameters	As specified in Attachment 1	As specified in Attachment 1
Laboratory Duplicate (MSD)		
TCL VOC	As specified in Attachment 1	As specified in Attachment 1
TCL BNA	As specified in Attachment 1	As specified in Attachment 1
TCL Pesticides/PCBs	As specified in Attachment 1	As specified in Attachment 1
TAL Inorganics	As specified in Attachment 1	As specified in Attachment 1
Miscellaneous Parameters	As specified in Attachment 1	As specified in Attachment 1
Accuracy Objectives		
Travel blanks		
TCL VOC	Less than the QL	Less than the QL
Equipment/Ambient Blanks		
TCL VOC	Less than the QL	Less than the QL
TCL BNA	Less than the QL	Less than the QL
TCL Pesticides/PCBs	Less than the QL	Less than the QL
TAL Inorganics	Less than the QL	Less than the QL
Miscellaneous Parameters	Less than the QL	N/A
Laboratory Blanks		
TCL VOC	Less than the QL	Less than the QL
TCL BNA	Less than the QL	Less than the QL
TCL Pesticides/PCBs	Less than the QL	Less than the QL
TAL Inorganics	Less than the QL	Less than the QL

Table 3-3 Criteria Objectives Cont'd

Precision Objectives	Aqueous	Solid/Other
Miscellaneous Parameters	Less than the QL	N/A
All TCL Fractions	As specified in Attachment 1	As specified in Attachment 1
Post - digestion spikes	As specified in Attachment 1	As specified in Attachment 1
TAL Inorganics	As specified in Attachment 1	As specified in Attachment 1
Misc. Parameters	As specified in Attachment 1	As specified in Attachment 1

NA - Non Applicable.

Precision and accuracy for the field pH and conductivity measurements are dependent on the type and condition of the instrument used and the care used in the standardization and operation. The precision and accuracy objectives for the instrumentation used are as follows:

- pH precision will be ±0.3 pH standard units and an accuracy of ±0.03 pH standard units. Field pH measurements will be reported to two significant figures.
- Conductivity precision will be ±3 µmhos/cm on the 500 µmhos/cm range, ±25 µmhos/cm on the 5,000 µmhos/cm range, and ±250 µmhos/cm on the 50,000 µmhos/cm range. Accuracy for the conductivity measurements is a function of the conductivity reading for the probe and instrument combined. Conductivity measurements will be reported to one significant figure for values below 10 and to two significant figures for values above 10.

To ensure sample representativeness, all sample collection will be performed in strict accordance with USEPA-recommended procedures for collection and preservation; USEPA-recommended holding times specified in the 29 June 1990 Federal Register, USEPA SW-846 (Test Methods for Evaluating Solid Waste), and the Engineering and Design-Chemical Data Quality Management for Hazardous Remedial Activities", USACE, Regulation No. 1110-1-263, 1 October 1990.

The data quality objective for the completeness of data with respect to the sampling (field investigation) is 100%. Although this goal appears rather ambitious, it can be attained. In the event 100% is not obtained, the effect of the uncollected data will be evaluated by the Project Manager as to its impact (if any) on project objectives. Corrective actions will be initiated to

resolve any data gaps from the original objectives, found as a result of less than 100% data completeness. Every effort will be made to obtain valid data for all sampling points, particularly those considered to be critical points. In this regard, the critical point samples which are identified will necessarily be selected as subsequent field QC samples (blind duplicates) at the frequency specified in Section 9.0.

In order to establish a degree of comparability such that observations and conclusions can be directly compared with all historical data, ERM will use standardized methods of field analysis, sample collection, holding times, and preservation. In addition, field conditions will be considered in evaluating sampling results in order to attain a high degree of data comparability.

3.3 *LABORATORY DATA QUALITY OBJECTIVES*

The laboratory will demonstrate analytical precision and accuracy by the analysis of laboratory duplicates and matrix spike duplicates. Precision (as well as instrument stability) will also be demonstrated by comparison of response factors for calibration standards. Laboratory accuracy will be demonstrated by the addition of surrogate and matrix spike compounds. Accuracy will be presented as percent recovery (R). Precision will be presented as relative percent differences (RPD), relative standard deviation (RSD), or percent difference (PD), whichever is applicable to the type of QC samples involved. Laboratory method blanks will also demonstrate accuracy with respect to the analyses. The frequencies of laboratory duplicates, matrix spikes and laboratory blanks are specified in Section 9.0. As considerable reference is made to Attachment 1 in the remainder of this QAPP, it is suggested it be reviewed at this time. The LLI and MSAI data quality objectives are detailed in Attachment 1.

The analytical laboratory will be expected to process (purge, extract, or digest) an aliquot of sample such that the analytical results will provide a high degree of representation with respect to the sampling point. In addition, the analytical laboratory will be expected to document all analytical problems encountered during the course of the investigation. Communication will be maintained with the laboratory so that analytical problems encountered with all sample points will allow these samples to be re-collected, if necessary. Further, the laboratory will be required to provide complete data deliverables, as discussed in Section 8.0 of this document to ERM.

3.4 *ON-SITE ANALYTICAL FACILITY DATA QUALITY OBJECTIVES*

Data Quality Objectives for the On-Site Analytical Facility are discussed in Attachment 2.

3.5 *CRITERIA OBJECTIVES*

The quantitative objectives (criteria) that ERM will require for both field and laboratory precision and accuracy are summarized in Table 3-3.

The laboratory will be expected (as an ideal objective) to report the quantitation limits (QL) for all samples in the appropriate statistical reporting units for all analyses. However, it should be noted that actual quantitation limits are sample specific and depend on variables such as dilution factors, sample matrices, percent moisture, and the specific analyte. The data reported at or near the QL will be handled cautiously since the stated data quality objectives for accuracy and precision may not "translate" well in some situations (i.e., accuracy and precision suffer for results near the QL).

3.6 *DATA MANAGEMENT OBJECTIVES*

It is a data management objective that all aspects of the investigation from sample design, collection, shipment, analysis use/decisions, etc. be performed in conjunction with rigorous QA/QC documentation. The specific details of this documentation can be found throughout this document.

It is expected that by the design of separate data quality requirements for field sampling and laboratory analysis, clear distinctions can be made such that any problems found in the system can be isolated with respect to the cause. Conversely, the data quality requirements are also designed to provide an indication of the variability inherit to the overall system.

The overall data management objective is to provide a complete data base with a high degree of confidence through the use of a phased approach of sampling, analysis, data assessment (data review), data qualification, and feedback.

4.0 SAMPLING PROCEDURES

The numbers of samples, locations, and justifications for sample media to be collected for the investigation are presented in Section 3.0 of the Work Plan. Sample collection and decontamination procedures for each medium are presented in Section 4.0 of the Work Plan.

Tables 4-1 through 4-3 present Sample Summary Matrices for the investigation. Table 4-4 presents the required field QC samples for the above-stated investigation.

Table 4-1
Soil/Sediment Sample Matrix Summary
Supplemental Studies Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time
Industrial Area - Pipeline Surficial/subsurface Soil (Direct Push Sampling)	60	On-site GC Analysis	Selected VOC's and BNA's	8021 Modified	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
Industrial Area - Pipeline to Lagoons and Waste Sump House Surficial/subsurface Soil (Soil Borings)	60	On-site GC Analysis	Selected VOC's and BNA's	8021 Modified	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	36	On-site GC/MS Analysis	TCL Volatiles	8260	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	40	Off-Site Analysis	TCL Semivolatiles	8270A	1-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days till extraction; analysis w/i 40 days of extract preparation.
	32	Off-Site Analysis	TCL Pesticides	8080	Same container as above.	14 days till extraction; analysis w/i 40 days of extract preparation.
	8	Off-Site Analysis	TCL Pesticides/PCBs	8080	Same container as above.	14 days till extraction; analysis w/i 40 days of extract preparation.
	40	Off-Site Analysis	TAL Metals	See Table 7-1.	Same container as above.	180 days; 28 days for mercury.
	40	Off-Site Analysis	Cyanide (Total and Amenable)	9010A or 9012	Same container as above.	14 days.
	40	Off-Site Analysis	Total Organic Carbon	9060	Same container as above.	28 days.
	40	Off-Site Analysis	Cation Exchange Capacity	9080	1-liter amber glass w/ Teflon lined enclosure.	NA

Analysis holding times are based from the date of sample collection.

Soil/Sediment [redacted]-1 Matrix Summary
Supplemental Studies Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time
Industrial Area - Pipeline to Lagoons and Waste Sump House Surficial/subsurface Soil (Shallow Monitoring Wells)	15	On-site GC Analysis	Selected VOC's and BNA's	8021 Modified	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	9	On-site GC/MS Analysis	TCL Volatiles	8260	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	10	Off-Site Analysis	TCL Semivolatiles	8270A	1-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	6	Off-Site Analysis	TCL Pesticides	8080	Same container as above.	14 days til extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TCL Pesticides/PCBs	8080	Same container as above.	14 days til extraction; analysis w/i 40 days of extract preparation.
	10	Off-Site Analysis	TAL Metals	See Table 7-1.	Same container as above.	180 days; 28 days for mercury.
	10	Off-Site Analysis	Cyanide (Total and Amenable)	9010A or 9012	Same container as above.	14 days.
	10	Off-Site Analysis	Total Organic Carbon	9060	Same container as above.	28 days.
	10	Off-Site Analysis	Cation Exchange Capacity	9080	1-liter amber glass w/ Teflon lined enclosure.	NA

Analysis holding times are based from the date of sample collection.

Table 4-1
Soil/Sediment Sample Matrix Summary
Supplemental Studies Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time
Industrial Area - Main Buildings Area Surficial/subsurface Soil (Soil Borings)	150	On-site GC Analysis	Selected VOC's and BNA's	8021 Modified	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	80	On-site GC/MS Analysis	TCL Volatiles	8260	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	100	Off-Site Analysis	TCL Semivolatiles	8270A	1-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days till extraction; analysis w/i 40 days of extract preparation.
	78	Off-Site Analysis	TCL Pesticides	8080	Same container as above	14 days till extraction; analysis w/i 40 days of extract preparation.
	22	Off-Site Analysis	TCL Pesticides/PCBs	8080	Same container as above	14 days till extraction; analysis w/i 40 days of extract preparation.
	100	Off-Site Analysis	TAL Metals	See Table 7-1.	Same container as above.	180 days; 28 days for mercury.
	100	Off-Site Analysis	Cyanide (Total and Amenable)	9010A or 9012	Same container as above.	14 days.
	100	Off-Site Analysis	Total Organic Carbon	9060	Same container as above.	28 days.
	100	Off-Site Analysis	Cation Exchange Capacity	9080	1-liter amber glass w/ Teflon lined enclosure.	NA

AR302963

Analysis holding times are based from the date of sample collection.

T[illegible]1
Soil/Sediment [illegible]atrix Summary
Supplemental [illegible]s Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time
Industrial Area - Main Buildings Area Surficial/subsurface Soil (Shallow Monitoring Wells)	15	On-site GC Analysis	Selected VOC's and BNA's	8021 Modified	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	9	On-site GC/MS Analysis	TCL Volatiles	8260	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	10	Off-Site Analysis	TCL Semivolatiles	8270A	1-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	10	Off-Site Analysis	TCL Pesticides/PCBs	8080	Same container as above	14 days til extraction; analysis w/i 40 days of extract preparation.
	10	Off-Site Analysis	TAL Metals	See Table 7-1	Same container as above	180 days, 28 days for mercury.
	10	Off-Site Analysis	Cyanide (Total and Amenable)	9010A or 9012	Same container as above	14 days.
	10	Off-Site Analysis	Total Organic Carbon	9060	Same container as above.	28 days.
	10	Off-Site Analysis	Cation Exchange Capacity	9080	1-liter amber glass w/ Teflon lined enclosure.	NA
Main Airport/Industrial Area Storm Sewers Sediment	30	Off-Site Analysis	TCL Volatiles	8260	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	30	Off-Site Analysis	TCL Semivolatiles	8270A	1-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	30	Off-Site Analysis	TCL Pesticides/PCBs	8080	Same container as above.	14 days til extraction; analysis w/i 40 days
	30	Off-Site Analysis	TAL Metals	See Table 7-1.	Same container as above.	180 days; 28 days for mercury.
	30	Off-Site Analysis	Cyanide (Total and Amenable)	9010A or 9012	Same container as above.	14 days.

Analysis holding times are based from the date of sample collection.

Table 4-1
Soil/Sediment Sample Matrix Summary
Supplemental Studies Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time
Meade Heights Sediment	4	Off-Site Analysis	TCL Volatiles	8260	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	4	Off-Site Analysis	TCL Semivolatiles	8270A	1-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days till extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TCL Pesticides/PCBs	8080	Same container as above.	14 days till extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TAL Metals	See Table 7-1.	Same container as above.	180 days; 28 days for mercury.
	4	Off-Site Analysis	Cyanide (Total and Amenable)	9010A or 9012	Same container as above.	14 days.
	4	Off-Site Analysis	Total Organic Carbon	9060	Same container as above.	28 days.
	4	Off-Site Analysis	Moisture Content	D2216-80	1-liter amber glass w/ Teflon lined enclosure.	NA
	4	Off-Site Analysis	Cation Exchange Capacity	9080	Same container as above.	NA
	4	Off-Site Analysis	Grain Size May need add. volume	D 421-85 and D422-63(90)	Same container as above.	NA
	4	Off-Site Analysis	pH	9045A	Same container as above.	14 days.

Analysis holding times are based from the date of sample collection.

Soil/Sediment [illegible] Matrix Summary
Supplemental [illegible] Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time
Susquehanna River Sediment	4	Off-Site Analysis	TCL Volatiles	8260	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	4	Off-Site Analysis	TCL Semivolatiles	8270A	1-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TCL Pesticides/PCBs	8080	Same container as above.	14 days til extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TAL Metals	See Table 7-1.	Same container as above.	180 days; 28 days for mercury.
	4	Off-Site Analysis	Cyanide (Total and Amenable)	9010A or 9012	Same container as above.	14 days.
	4	Off-Site Analysis	Moisture Content	D2216-80	1-liter amber glass w/ Teflon lined enclosure.	NA
	4	Off-Site Analysis	Cation Exchange Capacity	9080	Same container as above.	NA
	4	Off-Site Analysis	Grain Size	D 421-85 and D422-63(90)	Same container as above.	NA
	4	Off-Site Analysis	Total Organic Carbon	9060	Same container as above.	28 days.
	4	Off-Site Analysis	pH	9045A	Same container as above.	14 days.

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Analysis holding times are based from the date of sample collection.

Table 4-1
Soil/Sediment Sample Matrix Summary
Supplemental Studies Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time
Background Surficial/subsurface Soil	15	On-Site GC/MS Analysis	TCL Volatiles	8260	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	20	Off-Site Analysis	TCL Semivolatiles	8270A	1-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days till extraction; analysis w/i 40 days of extract preparation.
	20	Off-Site Analysis	TCL Pesticides	8080	Same container as above.	14 days till extraction; analysis w/i 40 days of extract preparation.
	20	Off-Site Analysis	TAL Metals	See Table 7-1.	Same container as above.	180 days; 28 days for mercury.
	20	Off-Site Analysis	Cyanide (Total and Amenable)	9010A or 9012	Same container as above.	14 days.
Soil Vapor Extraction Pilot Test	12	Off-Site Analysis	TCL Volatiles	8260	2-40 ml clear glass vials w/ Teflon lined enclosure. Cool to 4°C.	14 days.
	12	Off-Site Analysis	TCL Semivolatiles	8270A	1-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days till extraction; analysis w/i 40 days of extract preparation.
	12	Off-Site Analysis	Total Organic Carbon	9060	Same container as above.	28 days.
	12	Off-Site Analysis	Cation Exchange Capacity	9080	Same container as above.	NA

Analysis holding times are based from the date of sample collection.

Tab
Water Sampl ummary
Supplemental S nvestigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time (1)
North Base Landfill Direct Push Ground Water	75	On-Site GC Analysis	Selected VOCs & BNAs	8021A	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days
	16	Off-Site Analysis	TCL VOCs plus bis(2-chloroethyl)ether 1,2-, 1,3-, and 1,4-dichlorobenzenes	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days
Site-wide Existing Wells	5	Off-Site Analysis	TCL Volatiles (14-day turnaround)	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days.
Ground Water (Existing monitoring wells, production wells, and residential wells.)	70	Off-Site Analysis	TCL Volatiles	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days.
	70	Off-Site Analysis	TCL Semivolatiles	8270A	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	37	Off-Site Analysis	TCL Pesticides	8080	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	3	Off-Site Analysis	TCL Pesticides/PCBs	8080		
	70	Off-Site Analysis	TAL Metals (total)	See Table 7-1	1-liter plastic HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	48	Off-Site Analysis	TAL Metals (dissolved)	See Table 7-1	1-liter plastic, field filtered; HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	70	Off-Site Analysis	Cyanide (total and amenable)	9010A or 9012	1-liter glass NaOH to pH≥ 12	14 days.
Site-wide New Wells Ground Water	5	Off-Site Analysis	TCL Volatiles (14 day turnaround)	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days.
	49	Off-Site Analysis	TCL Volatiles	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days.
	49	Off-Site Analysis	TCL Semivolatiles	8270A	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	15	Off-Site Analysis	TCL Pesticides/PCBs	8080	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TCL Pesticides/PCBs	8080	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.

(1) Analysis holding times are based from the time of sample collection.

Table 4-2
Water Sample Matrix Summary
Supplemental Studies Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time (1)
Site-wide New Wells (con'd)	49	Off-Site Analysis	TAL Metals (total)	See Table 7-1	1-liter plastic HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	49	Off-Site Analysis	TAL Metals (dissolved)	See Table 7-1	1-liter plastic, field filtered; HNO3 To pH ≤ 2.	180 days, 28 days for mercury
	49	Off-Site Analysis	Cyanide (total and amenable)	9010A or 9012	1-liter glass NaOH to pH≥ 12	14 days.
HSA Production Wells Depth Specific Ground Water	30	Off-Site Analysis	TCL Volatiles	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days.
	30	Off-Site Analysis	TCL Semivolatiles	8270A	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	30	Off-Site Analysis	TCL Pesticides	8080	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	30	Off-Site Analysis	TAL Metals (total)	See Table 7-1	1-liter plastic HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	30	Off-Site Analysis	Cyanide (total and amenable)	9010A or 9012	1-liter glass	14 days.

(1) Analysis holding times are based from the time of sample collection.

Tab
Water Sample ummary
Supplemental St Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time (1)
Meade Heights Area Surface Water	4	Off-Site Analysis	TCL Volatiles	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days.
	4	Off-Site Analysis	TCL Semivolatiles	8270A	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TCL Pesticides/PCBs	8080	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TAL Metals (total)	See Table 7-1	1-liter plastic HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	4	Off-Site Analysis	Cyanide (total and amenable)	9010A or 9012	1-liter glass NaOH to pH >12	14 days.
	4	Off-Site Analysis	Hardness	130.1	1-liter plastic HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	4	Off-Site Analysis	Alkalinity	310.1	1-liter plastic Cool to 4°C.	14 days.
	4	Off-Site Analysis	Total Dissolved Solids	160.1	Same container as above.	14 days

(1) Analysis holding times are based from the time of sample collection.

Table 4-2
Water Sample Matrix Summary
Supplemental Studies Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time (1)
Susquehanna River Surface Water	4	Off-Site Analysis	TCL Volatiles	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C	14 days
	4	Off-Site Analysis	TCL Semivolatiles	8270A	2-liter amber glass w/ Teflon lined enclosure Cool to 4°C	14 days til extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TCL Pesticides/PCBs	8080	2-liter amber glass w/ Teflon lined enclosure Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TAL Metals (total)	See Table 7-1	1-liter plastic HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	4	Off-Site Analysis	Cyanide (total and amenable)	9010A or 9012	1-liter glass Cool to 4°C.	14 days
	4	Off-Site Analysis	Hardness	130.1	1-liter plastic HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	4	Off-Site Analysis	Alkalinity	310.1	1-liter plastic Cool to 4°C.	14 days.
	4	Off-Site Analysis	Total Dissolved Solids	160.1	Same container as above.	14 days.

(1) Analysis holding times are based from the time of sample collection.

Tab
Water Sample Summary
Supplemental S nvestigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time (1)
Deep 900' Wells Ground Water	3	Off-Site Analysis	TCL Volatiles	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days.
	3	Off-Site Analysis	TCL Semivolatiles	8270A	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	3	Off-Site Analysis	TAL Metals (total)	See Table 7-1	1-liter plastic HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	3	Off-Site Analysis	TAL Metals (dissolved)	See Table 7-1	1-liter plastic, field filtered; HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	3	Off-Site Analysis	Cyanide (total and amenable)	9010A or 9012	1-liter glass Cool to 4°C.	14 days.
Source Water	3	Off-Site Analysis	TCL Volatiles	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days.
	3	Off-Site Analysis	TCL Semivolatiles	8270A	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days til extraction; analysis w/i 40 days of extract preparation.
	3	Off-Site Analysis	TAL Metals (total)	See Table 7-1	1-liter plastic HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	3	Off-Site Analysis	TAL Metals (dissolved)	See Table 7-1	1-liter plastic, field filtered; HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	3	Off-Site Analysis	Cyanide (total and amenable)	9010A or 9012	1-liter glass Cool to 4°C.	14 days.

(1) Analysis holding times are based from the time of sample collection.

Table 4-3
Quarterly Sampling Matrix Summary
Supplemental Studies Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples Per Quarter	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time (1)
Sentinel Wells Five quarterly rounds will be conducted.	4	Off-Site Analysis	TCL Volatiles	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days.
	4	Off-Site Analysis	TCL Semivolatiles	8270A	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days till extraction; analysis w/i 40 days of extract preparation.
	2	Off-Site Analysis	TCL Pesticides	8080	2-liter amber glass w/ Teflon lined enclosure Cool to 4°C.	14 days till extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TAL Metals (total)	See Table 7 1	1 liter plastic HNO3 To pH ≤ 2	180 days. 28 days for mercury.
	4	Off-Site Analysis	TAL Metals (dissolved)	See Table 7 1	1 liter plastic. Field filtered, HNO3 To pH ≤ 2	180 days. 28 days for mercury.
	4	Off-Site Analysis	Cyanide (total and amenable)	9010A or 9012	1-liter glass NaOH to pH≥ 12	14 days.

(1) Analysis holding times are based from the time of sample collection.

Table
Quarterly Sampling Summary
Supplemental Studies Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples Per Quarter	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time (1)
Susquehanna River Surface Water Seven quarterly rounds will be conducted.	4	Off-Site Analysis	TCL Volatiles	8260	3-40 ml clear glass vials w/ Teflon lined enclosure HCL to pH ≤ 2. Cool to 4°C.	14 days.
	4	Off-Site Analysis	TCL Semivolatiles	8270A	2-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days till extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TCL Pesticides/PCBs	8080	2-liter amber glass w/ Teflon lined enclosure Cool to 4°C	14 days till extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TAL Metals (total)	See Table 7-1	1 liter plastic HNO3 To pH ≤ 2	180 days, 28 days for mercury.
	4	Off-Site Analysis	Cyanide (total and amenable)	9010A or 9012	1 liter glass Cool to 4°C	14 days
	4	Off-Site Analysis	Hardness	130.1	1-liter plastic HNO3 To pH ≤ 2.	180 days, 28 days for mercury.
	4	Off-Site Analysis	Alkalinity	310.1	1-liter plastic Cool to 4°C.	14 days.
	4	Off-Site Analysis	Total Dissolved Solids	160.1	Same container as above.	14 days.

(1) Analysis holding times are based from the time of sample collection.

Table 4-3
Quarterly Sampling Matrix Summary
Supplemental Studies Investigation
Middletown Airfield NPL Site
Harrisburg, Pennsylvania

Area	Number of Environmental Samples Per Quarter	Analysis Technique	Parameter	Analytical Method	Container and Preservation	Analysis Holding Time (1)
Susquehanna River Sediment Seven quarterly rounds will be conducted.	4	Off-Site Analysis	TCL Volatiles	8260	2-40 ml clear glass vials w/ Teflon lined Cool to 4°C.	14 days.
	4	Off-Site Analysis	TCL Semivolatiles	8270A	1-liter amber glass w/ Teflon lined enclosure. Cool to 4°C.	14 days till extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TCL Pesticides/PCBs	8080	Same container as above.	14 days till extraction; analysis w/i 40 days of extract preparation.
	4	Off-Site Analysis	TAL Metals (total)	See Table 7-1	Same container as above.	180 days, 28 days for mercury.
	4	Off-Site Analysis	Cyanide (total and amenable)	9010A or 9012	Same container as above.	14 days.
	4	Off-Site Analysis	Moisture Content	D2216-80	1-liter glass Cool to 4°C.	NA
	4	Off-Site Analysis	Cation Exchange Capacity	9080	Same container as above.	NA
	4	Off-Site Analysis	Grain Size	D421-85 and D422-63(90)	Same container as above.	NA
	4	Off-Site Analysis	Total Organic Carbon	9060	Same container as above.	28 days
	4	Off-Site Analysis	pH	9045A	Same container as above.	14 days

(1) Analysis holding times are based from the time of sample collection.

TA[illegible]
REQUIRED FIE[illegible]QC SAMPLES
SUPPLEMENTAL STUDIES INVESTIGATION
MIDDLETOWN AIRFIELD NPL SITE
HARRISBURG, PENNSYLVANIA

Field QC Sample Type	TCL VOCs	TCL SVOCs	TCL PEST/PCBs	TAL METALS	CYANIDE	ALKALINITY	HARDNESS	TOTAL DISSOLVED SOLIDS
Ground Water Sampling Program								
Travel Blanks	38							
Rinsate Blanks	0	38	38	38	38			
QA Samples	16	17	13	35	17			
Matrix Spike/Matrix Spike Duplicates	16	18	14	36	18			
Duplicates (Blind)	8	9	7	23	9			
Surface Water Sampling Program								
Travel Blanks	9							
Rinsate Blanks								
QA Samples	4	4	4	8	4	4	4	4
Matrix Spike/Matrix Spike Duplicates	4	4	4	8	4	4	4	4
Duplicates (Blind)	2	2	2	9	2	2	2	2
Subsurface Soil Sampling Program								
QA Samples	15	18	5	18	18			
Matrix Spike/Matrix Spike Duplicates	16	18	6	18	18			
Duplicates (Blind)	8	9	3	19	9			
Sediment Sampling Program								
QA Samples	4	4	4	4	4			
Matrix Spike/Matrix Spike Duplicates	4	4	4	4	4			
Duplicates (Blind)	2	2	2	2	2			

QC - Quality Control Samples

QA - Quality Assurance Samples. These samples will be sent to the USACE laboratory for analysis. All other QC sample analyses will be conducted by the off-site laboratory.

QC samples are estimated on the number of days spent in the field. This number is subject to change based on actual field time.
Samples will be collected at a frequency of 1 per 20 samples for MS/MSD analysis. Inorganic analysis will include a single matrix spike and a laboratory duplicate versus a matrix spike duplicate.
The numbers for QC Samples for metals in aqueous media include both total and dissolved analyses.

5.0 SAMPLE CUSTODY

The primary objective of sample custody procedures is to create an accurate written record which can be used to trace the possession and handling of all samples from the moment of their collection, through analysis, until their final disposition. Custody for samples collected during this investigation will be maintained by the Field Operations Manager (FOM). The FOM will be responsible for documenting each sample transfer and maintaining custody of all samples until they are shipped to the laboratory.

ERM will use laboratory-supplied I-Chem 300 Series bottles appropriate for each media as sample containers. All necessary chemical preservatives will be added to the bottles by the laboratory prior to the sampling event, where appropriate. Preservative type and source will be documented in ERM's field notebook.

A self-adhesive sample label will be affixed to each container before sample collection. At a minimum, the sample label will contain the following information, as shown on Figure 5-1:

- Client - Job Name (Middletown Airfield),
- ERM Traffic Report Number,
- Sample identification - place of sampling,
- Date and time collected,
- Sampler's initials,
- Testing required, and
- Preservatives added.

The liquid level will be indicated using a grease pencil on the outside of the sample container. This will provide a means for the laboratory to determine whether leaking of the sample container occurred during shipment. Immediately after sample collection, each sample bottle will be sealed in an individual plastic bag. Samples will then be placed immediately into an insulated cooler for shipment to the laboratory. ERM field Chain-of-Custody records (Figure 5-2) and an ERM Traffic Report (Figure 5-3) completed at the time of sample collection will accompany the samples inside the cooler for shipment to the laboratory. The samples will be properly relinquished on the field Chain-of-Custody record by the

Figure 5-1
Sample Container Labels
Middletown Airfield NPL Site

Client/W.O.#:

Traffic Report #:

Sample Identification:

Collection Information: ☐ *Composite* ☐ *Grab*

Date: *Time:* *By:*

Testing Required:

Preservative:

Environmental Resources Management, Inc.
855 Springdale Dr. • Exton, Pennsylvania 19341 • (215) 524-3500

Client/W.O. #

Traffic Report/Sample I.D.

Collection Information:

Date: *By:* *Time:*

Preservatives:

Environmental Resources Management, Inc. • Exton, Pennsylvania 19341 • (215) 524-3500

Figure 5-2
ERM Chain of Custody Record
Middletown Airfield NPL Site

Sample Chain of Custody

W.O. No.:	Project Name:														
Sample:															
ERM T.R. Number	Date	Time	COMP	GRAB	Sample Location	Number of Containers									Remarks

Sample Relinquished	Date	Time	Sample Received by:	Date	Time	Reason for Transfer

ERM, INC.

AR302979

FM005.02.01 EJK/rev. 2-18-94

Figure 5-3
ERM Traffic Report Form
Middletown Airfield NPL Site

Traffic Report

1 Project W.O.	2 Sample Concentration	0001	
Project Name/Location	☐ Low Concentration		
	☐ Medium Concentration	3 Ship to:	
	5 Sampling Personnel Contact		
4 Sample Matrix	Sampler		
☐ Liquid ☐ Solid	Project Manager		
☐ Other	Phone No. (215) 524-3500	Attn.:	

6 Shipping Information	7 Specify Type of Analyses, Number of Containers, Approx. Volume		
(Name of Carrier)	Analyses/Method Requested	No. of Bottles	Total Volume
(Date Shipped)			
(Airbill Number)			
8 Sample Location			
Date:			
Time:			

9 Sample Description		10 Special Handling (e.g. Safety Procedures/Hazardous)
☐ Surface Water	☐ Soil	
☐ Ground Water	☐ Solid	
☐ Leachate	☐ Other:	Additional Comments (Specify data package, rush work, special detection limits, etc.)
☐ Sediment		

11 Condition of Samples Received (to be completed by Laboratory Log-in.)

☐ Samples received intact	
☐ Samples at 4 degrees (C)	Log-in Person's Signature
☐ Samples not leaking	
☐ Container numbers match as specified in Item 7	
☐ Container tags match Chain of Custody	
☐ Cooler received with Custody Seals intact	☐ Samples contained within plastic bags

sampling team. These record forms will be sealed in a ziploc plastic bag to protect them against moisture. Each cooler will contain sufficient ice and/or ice packs to ensure that proper temperature is maintained and will be packed in a manner to prevent damage to sample containers. A member of the project team will then initial and custody seal (Figure 5-4) each sample cooler.

All coolers will be shipped by an overnight courier according to current US DOT regulations. Upon receiving the samples, the laboratory Sample Custodian will inspect the condition of the samples, compare the information on the sample labels against the field Chain-of-Custody record and Traffic Reports, assign a LLI or MSAI control identification number, and log the control number into the computer sample inventory system.

The preparation of all sample bottles (cleaning technique, preservative added, etc.) will be documented. When samples requiring preservation by either acid or base are received at the laboratory, the pH will be measured and documented. The Laboratory Sample Custodian will then store the sample in a secure sample storage cooler maintained at 4°C and maintain custody until the sample is assigned to an analyst for analysis. Custody will be maintained until disposal of the analyzed samples.

The Laboratory Sample Custodian will note any damaged sample containers or discrepancies between the sample label and information on the field Chain-of-Custody record logging the sample and will note any discrepancies in Section 11.0 of the ERM Traffic Report. The Laboratory Sample Custodian will also complete a Cooler Receipt Form (Figure 5-5). This information will also be communicated to the FOM or field personnel so that proper action can be taken. The Chain-of-Custody form will be signed by both the relinquishing and receiving parties each time the sample changes hands, and the reason for transfer indicated.

An internal Chain-of-Custody form will be used by the laboratory to document sample possession from the Laboratory Sample Custodian to analysts and final disposition. LLI and MSAI's internal custody is discussed in Attachment 1, Section 7. All Chain-of-Custody information will be supplied with the data packages for inclusion in the document control file.

The laboratory will be responsible for disposal of the unused sample aliquots according to appropriate disposal practices as specified in Section 7 of LLI and MSAI's Comprehensive Quality Assurance Plan, enclosed in Attachment 1.

Figure 5-4
ERM Custody Seal
Middletown Airfield NPL Site

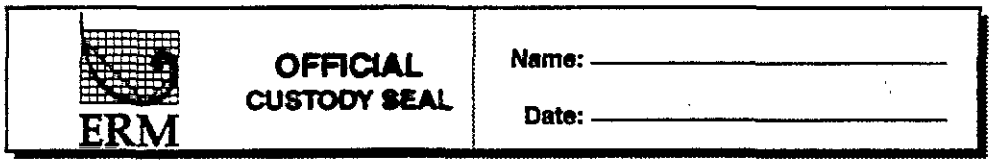


Figure 5-5
Cooler Receipt Form
Middletown Airfield NPL Site

PROJECT:_____ LIMS#_____

USE OTHER SIDE OF THIS FORM TO NOTE DETAILS CONCERNING CHECK-IN PROBLEMS.

A. PRELIMINARY EXAMINATION PHASE: Date cooler opened:_____ C-of-C Number:_____

by (print)_____(sign)_____

1. Did cooler come with a shipping slip (air bill,etc)?..... YES NO

   If YES, enter carrier name & air bill number here:_____

2. Were custody seals on outside of cooler?..... YES NO

   How many & where:_____, seal date:_____, seal name_____

3. Were custody seals unbroken and intact at the data and time of arrival?..... YES NO

4. Did you screen samples for radioactivity using the Geiger Counter?..... YES NO

5. Were custody papers sealed in a plastic bag & taped inside to the lid?..... YES NO

6. Were custody papers filled out properly (ink, signed, etc.)?..... YES NO

7. Did you sign custody papers in the appropriate place?..... YES NO

8. Was project identifiable from custody papers?. If yes, enter project name at the top of this form.... YES NO

9. If required, was enough ice used?..... Type of ice:_____..... YES NO

10. Have designated person initial here to acknowledge receipt of cooler:_____(date)_____

B. LOG-IN PHASE: Date samples were logged-in:_____

by (print)_____ (sign)_____

11. Describe type of packing in cooler:_____

12. Were all bottles sealed in separate plastic bags?..... YES NO

13. Did all bottles arrive unbroken & were labels in good condition?..... YES NO

14. Were all bottle labels complete (ID, date, time, signature, preservative, etc.)?..... YES NO

15. Did all bottle labels agree with custody papers?..... YES NO

16. Were correct containers used for the tests indicated?..... YES NO

17. Were correct preservatives added to samples?..... YES NO

18. Was a sufficient amount of sample sent for tests indicated?..... YES NO

19. Were bubbles absent in volatile samples? If NO, list by Sample #_____ YES NO

20. Was the project manager called and status discussed?. If yes, give details on the back of this form. YES NO

21. Who was called?_____ By whom?_____(date)_____

6.0 CALIBRATION PROCEDURES AND FREQUENCY

6.1 LABORATORY CALIBRATION

Laboratory calibration and frequency for all parameters are discussed in Attachment 1.

6.2 FIELD CALIBRATION

Field measurements of pH, specific conductance, and temperature will be taken for the ground water samples and surface water samples collected. Field technicians will be responsible for the calibration of field equipment. Calibration will be recorded directly into the field notebook.

Field equipment will be calibrated using standard solutions which have certified concentrations. These standards will be purchased from chemical supply houses. The frequency of field calibration procedures will, at a minimum, include the following:

- The specific conductance and pH meter will be calibrated a minimum of once at the beginning of the day and documented in the calibrator's field book (see Section 8.0). Calibration will be checked mid-day and at the end of the day to ensure proper measurements are taken;
- pH meters will be calibrated using specific techniques according to the manufacturer's instructions and two standard buffer solutions (either pH 4 and 7, or 7 and 10) obtained from chemical supply houses. The pH value of these buffers will be compensated for temperature according to the values supplied on the manufacturer's bottle label. The temperature (measured as below) at which the sample pH was measured will then be used to compensate for temperature on the meter. The same standard buffer solutions will be used to check the pH meter calibration;
- Temperature measurements will be performed using a field thermometer (Thomas Scientific Company No. 9329A10, or equivalent) and recorded to $\pm$ 0.2 degrees Celcius. The thermometer will be calibrated once to a certified NBS thermometer. Temperature measurements will be taken with the field thermometer in ice water and boiling water, and compared to those measured with the certified NBS thermometer. The appropriate calibration factor for the field

thermometer will be recorded and marked on the thermometer case; and

- Specific conductance meters will be calibrated according to manufacturer's instructions using a 1413.0 µmhos (KCI) solution prepared by ERM. The conductivity probe cell constant will be calculated according to the formula.

$$K = \frac{1413.0\ (C)}{1 + 0.02\ (T - 25°C)}$$

Where:

K = probe cell constant (unitless)
C = measured conductance value of standard
T = temperature (°C) of standard

Table 6-1 will be used to correct for the standard solution's conductivity value if it is not at 25°C.

Table 6-1 ***Conductivity Temperature Corrections for 1,413 UMHOS/CM Conductivity Standard***

Temperature °C	µmhos/cm
15	1,141.5
16	1,167.5
17	1,193.5
18	1,219.9
19	1,246.4
20	1,273.0
21	1,299.7
22	1,326.6
23	1,353.6
24	1,380.8
25	1,408.1
26	1,436.5
27	1,463.2
28	1,490.9
29	1,518.7
30	1,546.7

Using the cell constant calculated above and the following formula, field specific conductance measurements will be corrected to 25°C.

$$S = K \times C / (1 + 0.02\ (T - 25))$$

Where:

S = Specific conductance at 25°C (µmhos/cm)
K = calculated cell constant
C = field specific conductance (µmhos/cm)
T = temperature (°C) of sample at which conductance was measured

- The Foxboro Century OVA 128 will be calibrated to a methane in air standard (approximately 100 ppm) daily to ensure total volatile organic readings are accurate. If calibration problems are encountered, calibration will become more frequent as required. The methane in air standard is manufactured by Liquid Carbonic and is marked with its certified concentration. The standard is run directly into the intake of the pickup probe and the gain adjustment of the OVA 128 is then used to calibrate the reading to the standard concentration. Any OVA, total volatile organic readings will be reported as "X ppm as methane."

6.3 *ON-SITE ANALYTICAL FACILITY*

All calibration procedures and frequency for the On-site Analytical Facility are described in Attachment 2 of this document.

7.0 ANALYTICAL PROCEDURES

7.1 LABORATORY ANALYTICAL PROCEDURES

All analytical procedures to be used are officially approved USEPA procedures. The appropriate sample preparation and analysis methods and required holding times are given in Tables 4-1, 4-2 and 4-3.

The primary analyte list will be the Target Compound List (TCL) and the Target Analyte List (TAL). In addition to the TCL/TAL analyses, some samples will be analyzed for total organic carbon (TOC) and miscellaneous parameters, as indicated in Tables 4-1, 4-2 and 4-3.

The analytical methods which are to be used for the analysis of the sample media collected at the Site will be in accordance with "Test Methods for Evaluating Solid Waste", USEPA SW-846, third edition, updated July 1992, and "Methods for Chemical Analysis of Water and Wastes", USEPA-600/4-79-020, revised March 1983. Method references for individual metals are presented in Table 7-1. These methods were chosen to provide comparability with other data that will be collected for the investigation and to meet the project DQOs. These methods are the most appropriate to achieve all DQOs.

Samples, as indicated in Table 3-1 of the Workplan, will be submitted for the following geotechnical parameters: grain size distribution, atterberg limits, and moisture content. Geotechnical testing will be conducted by ERM's in-house laboratory.

Table 7-2 presents the list of organic, inorganic, and miscellaneous constituents and their respective quantitation limits (QLs) for the investigation. The TCL volatile and semivolatile organic fractions will also include mass spectral library searching for up to 10 additional volatile and 20 additional semivolatile, non-target (non-TCL) compounds.

7.2 ON-SITE ANALYTICAL FACILITY PROCEDURES

Procedures for the On-site Analytical Facility analyses are discussed in Attachment 2.

Table 7-1 Method Reference Numbers for the Middletown Airfield Metals Analyses

Metal	Method Number*
Antimony	6010A
Arsenic	7061
Barium	6010A
Beryllium	6010A
Cadmium	6010A
Chromium (total)	6010A
Copper	6010A
Iron	6010A
Lead	7421
Manganese	6010A
Mercury	7470/7471
Nickel	6010A
Selenium	7741
Silver	6010A
Sodium	6010A
Thallium	7841
Zinc	6010A

*Arsenic, lead, selenium, and thallium analysis methods utilize Graphite Furnace Atomic Absorption (GFAA) Spectroscopy. Mercury analyses are performed using Cold Vapor Atomic Absorption Spectroscopy. All other metals analysis methods are Inductively Coupled Plasma (ICP) Emission Spectroscopy methods.

7.3 *USACE LABORATORY VALIDATION*

LLI and MSAI will attain the USACE validation for the analytical methods that they will be performing for the investigation prior to receiving samples.

Table 7-2 presents the list of organic, inorganic, and miscellaneous constituents and their respective quantitation limits (QLs) for the investigation.

Table 7-2 Middletown Airfield Organic and Inorganic Constituents for Analysis and Quantitation /Detection Limits (QL)

Volatiles	CAS Number	Quantitation Limits[a] Low Water µg/L	Low Soil/ Sediment[b] µg/Kg
1. Chloromethane	74-87-3	10	10
2. Bromomethane	74-83-9	10	10
3. Vinyl Chloride	75-01-4	10	10
4. Chloroethane	75-00-3	10	10
5. Methylene Chloride	75-09-2	5	5
6. Acetone	67-64-1	100	100
7. Carbon Disulfide	75-15-0	100	100
8. 1,1-Dichloroethene	75-35-4	5	5
9. 1,1-Dichloroethane	75-35-3	5	5
10. 1,2-Dichloroethene (total)	540-54-0	5	5
11. Chloroform	67-66-3	5	5
12. 1, 2-Dichloroethane	107-06-2	5	5
13. 2-Butanone	78-93-3	100	100
14. 1,1,1-trichloroethane	71-55-6	5	5
15. Carbon Tetrachloride	56-23-5	5	5
16. Bromodichloromethane	75-27-4	5	5
17. 1,1,2,2-Tetrachloroethane	79-34-5	5	5
18. 1,2-Dichloropropane	78-87-5	5	5
19. cis-1,3-Dichloropropene	10061-01-5	5	5
20. Trichloroethene	79-01-6	5	5
21. Dibromochloromethane	124-48-1	5	5
22. 1,1,2-1,1,1-trichloroethane	79-00-5	5	5
23. Benzene	71-43-2	5	5
24. trans-1,3-Dichloropropene	10061-02-6	5	5
25. Bromoform	75-25-2	5	5
26. 2-Hexanone	591-78-6	50	50
27. 4-Methyl-2-Pentanone	108-10-1	50	50
28. Tetrachloroethane	127-18-4	5	5
29. Toluene	108-88-3	5	5

Table 7-2 ***Middletown Airfield***
Organic and Inorganic Constituents for Analysis and Quantitation /Detection Limits (QL)
(continued)

Volatiles	CAS Number	Quantitation Limits[a] Low Water µg/L	Low Soil/ Sediment[b] µg/Kg
30. Chlorobenzene	108-90-7	5	5
31. Ethyl Benzene	100-41-4	5	5
32. Styrene	100-42-5	5	5
33. Total Xylenes	100-42-5	5	5

[a] Specific quantitation limits are highly matrix dependent. The quantitation limits which are listed may not always be achievable.

[b] - Quantitation limits for soil/sediment are based on wet weight. Individual sample quantitation limits will be different based on dry weight correction. Medium Level Soil/Sediment Contract Required Quantitation Limits (CRQL) for Volatile TCL Compounds are 125 times the individual Low Level Soil/Sediment CRQL.

Table 7-2 ***Middletown Airfield Organic and Inorganic Constituents for Analysis and Quantitation /Detection Limits (QL) (continued)***

Semivolatiles	CAS Number	Quantitation Limits[a] Low Water µg/L	Low Soil/ Sediment[c] µg/Kg
34. Phenol	108-95-2	10	330
35. bis(2-Chloroethyl)ether *	111-44-4	10	330
36. 2-Chlorophenol	95-57-8	10	330
37. 1,3-Dichlorobenzene *	541-73-1	10	330
38. 1,4-Dichlorobenzene *	95-50-1	10	330
39. 1,2-Dichlorobenzene *	95-50-1	10	330
40. 2-Methylphenol	95-48-7	10	330
41. bis(2-Chloroisopropyl) ether	108-60-1	10	330
42. 4-Methylphenol	106-44-5	10	330
43. N-Nitroso-Di-n-propylamine	621-64-7	10	330
44. Hexachloroethane	67-72-1	10	330
45. Nitrobenzene	98-95-3	10	330
46. Isophorone	78-59-1	10	330
47. 2-Nitrophenol	88-75-5	10	330
48. 2,4-Dimethylphenol	105-67-9	10	330
49. bis(2-Chloroethoxy)methane	111-91-1	10	330
50. 2,4-Dichlorophenol	120-83-2	10	330
51. 1,2,4-Trichlorobenzene	120-82-1	10	330
52. Naphthalene	91-20-3	10	330
53. 4-Chloroaniline	106-47-8	10	330
54. Hexachlorobutadiene	87-68-3	10	330
55. 4-Chloro-3-methylphenol	59-50-7	10	330
56. 2-Methylnaphthalene	91-57-6	10	330
57. Hexachlorocyclopentadiene	77-47-4	10	330
58. 2,4,6-Trichlorophenol	88-06-2	10	330
59. 2,4,5-Trichlorophenol	95-95-4	25	800
60. 2-Chloronaphthalene	91-58-7	10	330
61. 2-Nitroaniline	88-74-4	25	800
62. Dimethyl Phthalate	131-11-3	10	330
63. Acenaphthylene	208-96-8	10	330
64. 3-Nitroaniline	99-09-2	25	800
65. Acenaphthene	83-32-9	10	330
66. 2, 4-Dinitrophenol	51-28-5	25	800
67. 4-Nitrophenol	100-02-7	25	800
68. Dibenzofuran	132-64-9	10	330
69. 2,4-Dinitrotoluene	121-14-2	10	330
70. 2,6-Dinitrotoluene	606-20-2	10	330

Table 7-2 ***Middletown Airfield***
Organic and Inorganic Constituents for Analysis and Quantitation /Detection Limits (QL)
(continued)

Semivolatiles	CAS Number	Quantitation Limits[a] Low Water µg/L	Low Soil/ Sediment[c] µg/Kg
71. Diethylphthalate	84-66-2	10	330
72. 4-Chlorophenyl Phenyl ether	7005-72-3	10	330
73. Fluorene	86-73-7	10	330
74. 4-Nitroaniline	100-01-6	25	800
75. 4,6-Dinitro-2-methylphenol	534-52-1	25	800
76. N-nitrosodiphenylamine	86-30-6	10	330
77. 4-Bromophenyl Phenyl ether	101-55-3	10	330
78. Hexachlorobenzene	118-74-1	10	330
79. Pentachlorophenol	87-86-5	25	800
80. Phenanthrene	85-01-8	10	330
81. Carbazole	86-74-8	10	330
82. Anthracene	120-12-7	10	330
83. Di-n-butylphthalate	84-74-2	10	330
84. Fluoranthene	206-44-0	10	330
85. Pyrene	129-00-0	10	330
86. Butyl Benzyl Phthalate	85-68-7	10	330
87. 3,3'-Dichlorobenzidine	91-94-1	10	330
88. Benzo(a)anthracene	56-55-3	10	330
89. bis(2-ethylhexyl)phthalate	117-81-7	10	330
90. Chrysene	218-01-9	10	330
91. Di-n-octyl Phthalate	117-84-0	10	330
92. Benzo(b)fluoranthene	205-99-2	10	330
93. Benzo(k)fluoranthene	207-08-9	10	330
94. Benzo(a)pyrene	50-32-8	10	330
95. Indeno(1,2,3-cd)pyrene	193-39-5	10	330
96. Dibenz (a,h)anthracene	53-70-3	10	330
97. Benzo(g,h,i)perylene	191-24-2	10	330

[c] - Quantitation limits for soil/sediment are based on wet weight. Individual sample quantitation limits will be different based on dry weight correction. Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Semivolatile TCL Compounds are 30 times the individual Low Soil/Sediment CRQL.

* - A quantitation limit of 5 µg/L will be required for this compound for ground water samples collected from the North Base Landfill Area.

Table 7-2 ***Middletown Airfield***
Organic and Inorganic Constituents for Analysis and Quantitation /Detection Limits (QL)
(continued)

Pesticides/PCBs	CAS Number	Quantitation Limits[a] Low Water µg/L	Low Soil/ Sediment[d] µg/Kg
98. alpha-BHC	319-84-6	0.05	1.7
99. beta-BHC	319-85-7	0.05	1.7
100. delta-BHC	319-86-8	0.05	1.7
101. gamma-BHC (Lindane)	58-89-9	0.05	1.7
102. Heptachlor	76-44-8	0.05	1.7
103. Aldrin	309-00-2	0.05	1.7
104. Heptachlor Epoxide	1024-57-3	0.05	1.7
105. Endosulfan I	959-98-8	0.05	1.7
106. Dieldrin	60-57-1	0.10	3.3
107. 4,4'-DDE	72-55-9	0.10	3.3
108. Endrin	72-20-8	0.10	3.3
109. Endosulfan II	33213-65-9	0.10	3.3
110. 4,4'-DDD	72-54-8	0.10	3.3
111. Endosulfan Sulfate	1031-07-8	0.10	3.3
112. 4,4'-DDT	50-29-3	0.10	3.3
113. Endrin aldehyde	7421-93-4	0.10	3.3
114. Endrin ketone	53494-70-5	0.1	3.3
115. Methoxychlor	72-43-5	0.5	17.0
116. alpha-chlordane	5103-71-9	0.05	1.7
117. gamma-chlordane	5103-74-2	0.05	1.7
118. Toxaphene	8001-35-2	5.0	170.0
119. Aroclor-1016	12674-11-2	1.0	33.0
120. Aroclor-1221	11104-28-2	2.0	67.0
121. Aroclor-1232	11141-16-5	1.0	33.0
122. Aroclor-1242	53469-21-9	1.0	33.0
123. Aroclor-1248	12672-29-6	1.0	33.0
124 Aroclor-1254	11097-69-1	1.0	33.0
125. Aroclor-1260	11086-82-5	1.0	33.0

[d] - Quantitation limits for soil/sediment are based on wet weight. Individual sample quantitation limits will be different based on dry weight correction. Medium Level Soil/Sediment Contract Required Quantitation Limits (CRQL) for Pesticide/PCB TCL Compounds are 30 times the individual Low Level Soil/Sediment CRQL.

Table 7-2 *Middletown Airfield*
Organic and Inorganic Constituents for Analysis and Quantitation /Detection Limits (QL)
(continued)

Elements Determined by Inductively Coupled Plasma Emission or Atomic Absorption Spectroscopy

Element (TAL Inorganics)	Quantitation Limit Water (µg/L)	Quantitation Limit Soil[e] (mg/Kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1
Cadmium	5	1
Calcium	5000	1000
Chromium	10	2
Cobalt	50	10
Copper	25	5
Iron	100	20
Lead	3	0.6
Magnesium	5000	1000
Manganese	15	3
Mercury	0.2	0.1
Nickel	40	8
Potassium	5000	1000
Selenium	5	1
Sodium	5000	1000
Silver	10	2
Thallium	10	2
Vanadium	50	10
Zinc	20	4

[e] Soil CRDL's presented are based on wet weight. Individual sample detection limits will be different based on dry weight correction.

Table 7-2 ***Middletown Airfield***
Organic and Inorganic Constituents for Analysis and Quantitation /Detection Limits (QL)
(continued)

Miscellaneous Parameters

Analyte	Quantitation Limi Water (mg/L)	Quantitation Limi Solid (mg/Kg)[e]
Cyanide	0.010	0.5
Hardness	10	NA
Alkalinity	1	NA
Total Dissolved Solids	10	NA

[e] Soil QL's presented are based on wet weight. Individual sample detection limits will be different based on dry weight correction.

7.4 ANALYTICAL METHOD SUMMARIES

7.4.1 TCL Volatile Organic Compounds

TCL volatile organic compounds (VOCs) will be analyzed using a purge and trap gas chromatography/ mass spectrometry (GC/MS) method. A 5-mL aliquot (water samples) or 5 gm in 5 mL of dilution water (solid samples) is purged with helium in a purge and trap system. The purged compounds are swept to a cooled silica gel sorbent trap and subsequently desorbed onto a GC column. The compounds are separated on the GC column and detected using a mass spectrometer (MS).

7.4.2 TCL Semivolatile Organic Compounds

TCL semivolatile organic compounds (SVOCs) will be analyzed by a GC/MS method. Water samples are sequentially extracted with methylene chloride at a pH greater than 12 and a pH less than 2 to obtain both the base/neutral and acid fractions. The two extracts are

concentrated and subsequently combined. Solid samples are extracted with a 1:1 ratio of methylene chloride to acetone and the extract concentrated. A 2-µL aliquot of the extract is injected onto a fused-silica capillary column to separate the compounds for detection by MS. The MS provides qualitative and quantitative analysis of the target compounds.

7.4.3 TCL Pesticides/PCBs

TCL Pesticides/PCB compounds will be analyzed by a GC method. Water samples are extracted using methylene chloride. Solid samples are extracted with a 1:1 methylene chloride to acetone mixture. Extracts are exchanged into hexane and analyzed on a GC using a packed (or capillary) chromatography column and an electron capture detector. Compounds detected on the primary column are confirmed on a second confirmation column before they are reported as positive results.

7.4.4 TAL/PPL Metals

7.4.4.1 TAL Metals by Inductively Coupled Plasma Spectrometry or Graphite Furnace Atomic Absorption

The TAL/PPL metals (except mercury) will be analyzed by Inductively Coupled Plasma Spectrometry (ICP) or Graphite Furnace Atomic Absorption (GFAA). The samples are prepared by digesting an aliquot with acid (nitric or hydrochloric) and hydrogen peroxide. Separate digestions are required for the ICP metals and GFAA metals. The digestates are analyzed by ICP or GFAA.

7.4.4.2 Mercury by Cold Vapor Atomic Absorption

Mercury will be analyzed by cold vapor atomic absorption (CVAA). The samples are prepared by heating at 95° C with nitric acid, sulfuric acid, potassium permanganate, and potassium persulfate. The digested sample is then measured by CVAA.

7.4.5 Cyanide

Cyanide will be determined using a colorimetric technique. By refluxing the sample with strong acid, cyanide complexes are broken apart. Cyanide in the form of hydrocyanic acid (HCN) is distilled into an absorber-scrubber containing sodium hydroxide solution. Cyanide is then converted to cyanogen chloride by reaction with chloramine-T at a pH less than eight. Pyridine-barbituric acid reagent is added to give a red-colored

complex. Absorbance is read at 578 nm and is compared to a standard curve to determine the amount of cyanide in the sample.

7.4.6 *Hardness*

The sample is titrated with Ethylenediaminetetraacetic acid (EDTA) to an endpoint of 10.

7.4.7 *Alkalinity*

An unaltered sample is titrated to an electrochemically determined endpoint of pH 4.5.

7.4.8 *Total Dissolved Solids*

A well mixed sample is filtered through a standard glass filter. The filtrate is evaporated and dried to a constant weight at a temperature of 180 ° C.

8.0 DATA REPORTING, VALIDATION, AND REDUCTION

Data validation practices will be followed to ensure that raw data are not altered and that an audit trail is developed for those data which required reduction. All the field data, such as those generated during field measurements, observations, and field instrument calibrations, will be entered directly into a bound field notebook.

Upon receipt of the sample data packages, the laboratory data generated for ten percent of the samples collected will be quantitatively and qualitatively validated by ERM's Quality Assurance Chemist/Laboratory Coordinator. Data validation is discussed in detail in Section 12.0.

It is anticipated that ERM's data reduction for this investigation will consist primarily of tabulating LLI and MSAI's analytical results onto summary tables through the use of computerized spreadsheet software. All LLI and MSAI analytical data will be provided in the form of diskette deliverables. This data will be loaded into ERM's Oracle database. All reduced data will be placed in the central file maintained by the Project Manager.

The laboratory will be responsible for providing deliverables within 45 days of its receipt of the last sample in any given lot. Analytical data for soil/solid matrices will be reported as µg/Kg (TCL parameters) and mg/Kg (TAL, PPL, and miscellaneous parameters). Analytical data for aqueous matrices will be reported as µg/L (TCL/TAL parameters) and mg/L (miscellaneous parameters). Data packages associated with the TCL/TAL analyses of samples collected during the investigation will be prepared utilizing USEPA CLP-equivalent data package deliverable formats. The deliverable requirements for all parameters are presented in Table 8-1.

In addition to the above deliverables, the laboratory will provide the following deliverables for inclusion in the Daily Quality Control Report and the Quality Control Summary Report. The Daily Quality Control Report and the Quality Control Summary Report are discussed in detail in Section 14.0.

- The laboratory will forward each week, on the Monday following a week of sampling, a Sample Receipt Acknowledgment Form, summarizing the samples received during the week and the analysis parameters for which the samples were entered into the Laboratory's

Information Management System . Any problems, discrepancies, etc. noted during laboratory sample receipt/log-in and the manner of resolution will be discussed. This information will be forwarded to the USACE Technical Manager as part of the Daily Quality Control Report.

- Quality Control Summary Packages, containing tabulations of surrogate recoveries, matrix spike/matrix spike duplicate analysis results, laboratory method blank analysis results, and other quality control data will be provided by the laboratory in addition to the data packages. These Quality Control Summary Packages will be provided to the Omaha District as part of the Quality Control Summary Report.

Results for samples submitted to the laboratory for accelerated turnaround time analyses will be provided by the laboratory to the Field Operations Manager (FOM) within 10 calendar days of sample receipt. This accelerated turnaround will ensure the delivery of results to USACE by the FOM within the required 14 days of sample receipt by the laboratory.

All raw field data will be summarized, reduced, or tabulated for use in the investigation reports by the Project Manager. All laboratory analytical data will be summarized and tabulated upon receipt, and the data submitted to the project team for use in the investigation reports.

ERM will require a rigorous data control program which will ensure that all documents for the investigations are accounted for as they are completed. Accountable documents include items such as logbooks, field data records, correspondence, chain-of-custody records, analytical reports, data packages, photographs, computer disks, and reports. The Project Manager is responsible for maintaining a central file in which all accountable documents will be inventoried.

The documentation of sample collection will include the use of bound field logbooks in which all information on sample collection and field instrument calibration will be entered in indelible ink. Appropriate information will be entered to reconstruct the sampling event, including site name (top of each page), sample identification, brief description of sample, date and time of collection, sampling methodology, field measurements and observations, and sampler's initials (bottom of each page with date). ERM's Sampling Notebook SOP is presented as Figure 8-1.

8.1 ON-SITE ANALYTICAL FACILITY DATA VALIDATION, REPORTING AND REDUCTION

The On-site Analytical Facility (OAF) will provided analytical results to the PM and USACE within 24 hours of sample receipt. Procedures for OAF data reporting, validation, and reduction are discussed in Attachment 2 of this document.

Table 8-1 Required Deliverables for CLP-Equivalent Format

- **Title Page** - present site name, field sample numbers and corresponding laboratory control numbers and the appropriate laboratory manager's signature authorizing release of the data.
- **Case Narrative** - summarize any problems encountered during analysis and discuss any corrective actions taken.
- **Table of Contents** - list all major sections of the delivered document with the referenced page numbers. This can be incorporated onto the Title Page.
- **ERM Chain of Custody Forms, Traffic Report Forms and Cooler Receipt Forms** - copies of the documents signed by the laboratory sample log-in personnel.
- **Laboratory Chronicle** - supply the dates of preparation and analysis for each analysis fraction and sample.
- **Methodology Summary** - present a brief summary of the method used and the appropriate method reference.
- **Analysis Reports** - present the analyte and indicate the values for positive hits, the quantitation limit, and moisture content for soil samples. Report an individual analysis report for each sample. Soil sample results must be reported on a dry weight basis.
- **Quality Control Summaries** - for GC/MS analyses, present summary forms of surrogate compound recoveries, matrix spike/matrix spike duplicate recoveries, quality control sample analysis results, mass tuning results, calibration standard data, shifts in internal standard areas and retention times relative to the associated continuing calibration standard, and method blank analysis results.

  For GC analyses, present summary forms of surrogate compound recoveries, matrix spike/matrix spike duplicate recoveries, quality control sample analysis results, calibration standard data, shifts in

retention times of surrogate compounds, and method blank analysis results.

For metals analyses, present summary forms of matrix spike sample analysis results, laboratory control sample analysis results, calibration verification results, shifts in internal standard areas and retention times relative to the associated continuing calibration standard, and preparation blank and calibration blank analysis results, ICP serial dilution results, method of standard addition results, and ICS sample analysis results. For miscellaneous parameter analyses, present summary forms of matrix spike sample analysis results, laboratory control sample analysis results, and laboratory method blank results.

GC/MS Analysis Data

- **Raw Sample Data** - provide reconstructed ion chromatogram (RIC) or total ion chromatograms (TIC) and instrument quantitation reports which include library list of compounds, quantitation ion, peak retention times, peak areas, and raw concentration data. Provide confirmation mass spectra (raw and background-subtracted for both sample and standard) for targeted compounds. Provide soil sample extraction or preparation logs.
- **Standards Data Package**
  - **Initial Calibration** - provide RIC or TIC chromatograms and instrument quantitation reports which include library list of compounds, quantitation ions, peak retention times, peak areas, and raw concentration data for each level standard associated with the initial calibration. Provide response factors for each standard.
  - **Continuing Calibration** - provide RIC or TIC chromatograms and instrument quantitation reports which include library list of compounds, quantitation ions, peak retention times, peak areas, and raw concentration data for all continuing calibration standards. Provide response factors and indicate if acceptance criteria was met for the continuing calibration.
- **Raw Quality Control Data** - provide RIC or TIC chromatograms and instrument quantitation reports which include library list of compounds, peak retention times, peak areas, and raw concentration data for each method blank and the matrix spike and matrix spike duplicate. Provide confirmation mass spectra (raw and background-subtracted for both sample and standard) for targeted compounds. Provide mass list and bar spectra for each GC/MS tune.

GC Analysis Data

- **Raw Sample Data** - provide GC chromatograms and instrument quantitation reports which include library list of compounds, peak retention times, peak areas, peak heights and raw concentration data. Chromatograms must be provided for both primary and confirmation columns. Provide soil sample extraction or preparation logs. Provide an example of how positive results are calculated.
- **Standards Data Package**
  - **Initial Calibration** - provide GC chromatograms and instrument quantitation reports which include library list of compounds, peak retention times, peak areas, peak heights and raw concentration data for each level standard associated with the initial calibration. Provide response factors for each standard.
- **Continuing Calibration** - provide GC chromatograms and instrument quantitation reports which include library list of compounds, peak retention times, peak areas, peak heights and raw concentration data for all check standards. Provide response factors and indicate if acceptance criteria was met for the continuing calibration.
- **Raw Quality Control Data** - provide GC chromatograms and instrument quantitation reports which include library list of compounds, peak retention times, peak areas, peak heights and raw concentration data for each method blank and the matrix spike and matrix spike duplicate.
- **Miscellaneous Quality Control Data** - Run logs presenting the chronology of sample and standard analysis and surrogate retention time shifts must be provided for both the primary and confirmation columns.

Metals Data

- **Raw Sample Data** - provide ICP instrument printouts for each sample, quality control sample and blank.
- **Standards Data** - Provide tabulations of calibration verification standard and interference check standard results. Provide associated raw data.
- **Miscellaneous Quality Control Data** - provide tabulations of laboratory control sample, ICP serial dilution, method of standard addition results. Provide associated raw data. Provide tabulations

instrument detection limits, ICP element linear ranges, interelement correction factors, and instrument run logs.

Wet Chemistry Data

- **Raw Sample Data** - provide instrument printouts or photocopies of laboratory notebook records of raw sample data. Provide soil sample extraction or preparation logs.
- **Standards Data** - provide instrument printout or laboratory notebook records associated with the initial and continuing calibrations.

Figure 8-1 Sampling Logbook SOP

One or more bound books will be maintained for each site; the book(s) will remain with the site evidence file. Copies should be made for the person who made the entries and the PM if requested.

All entries in the Logbook must be made in ink.

First Page should contain:

- Site name and number,
- Date and time started, and
- Personnel on-site.

Next page(s) DTW for all wells if required by the sampling plan. S/N of the DTW meter.

Each new day should contain:

- Date and time started,
- Weather,
- Personnel on-site — including any non-ERM personnel, and
- Sampling information (see next page).

* When a mistake is made in the Log, put a single line through it in ink and initial and date.

Figure 8-1 Continued

Sample Information

- Sample # (Traffic Report)
- Date and Time Sample collected
- Source of Sample (well, stream, domestic well, field etc.)
- Purged Well - type of equipment, purge volume, rate of purge, and decontamination procedures
- Location of Sample - document with a site sketch and/or written description, where sample was taken so that it could be found again
- How was sample taken? (bailer, trowel, SS spoon, thief, etc.)
- Analysis and QA/QC required (601, 602, Metals, Tier I, Tier II, etc.)
- Chemical Preservation used (HNO3, H2SO4, NaOH, etc.)
- Field instrument calibration including date of calibration, standards used and their source, results of calibration and any corrective actions taken
- Field Data (pH, DO, spec. conductance, temp., etc.)
- Field Observations - significant observation should be documented
  - Sample condition (color, odor, turbidity, oil, sheen)
  - Site condition (stressed vegetation, exposure of buried wastes, erosion problems, etc.)
- How sample was shipped, date, time and where to, and if legal seals were attached to transport container(s)
- Comments - Any observation or event that occurred that would be relevant to the site; for example, weather changes or effect it had on sampling, conversations with the client, public official or private citizen; instrument calibration, equipment problems, etc.

9.0 INTERNAL QUALITY CONTROL CHECKS

9.1 LABORATORY INTERNAL QUALITY CONTROL CHECKS

LLI and MSAI's Internal Quality Control Checks are presented in Attachment 1. A discussion of ERM's Field Internal Quality Control Checks is presented below.

9.2 FIELD INTERNAL QUALITY CONTROL CHECKS

Field internal QC checks will be utilized during this investigation through the use of the following:

- Travel Blanks - These blanks consist of ultrapure, deionized water contained in each sample container with any preservatives required for that analysis. ERM will be supplied ultrapure deionized water travel blanks by the analytical laboratory in each cooler containing sample bottles for TCL VOCs. These blanks will accompany the samplers during the sampling process and will serve as QC check on container cleanliness, external contamination, and the analytical method. Travel blanks will be submitted one per cooler for aqueous samples being submitted for TCL VOCs. Such trip blank will stay with the cooler until such cooler is returned to the analytical laboratory;
- Equipment Rinsate Blanks - Equipment rinsate blanks will be collected to ensure that sampling equipment is clean and that the potential for cross contamination has been minimized by the equipment decontamination procedures. These blanks will be collected by decontaminating the sampling device and then pouring ultrapure deionized water (from the Hydros® system) over the device. This rinsate water will be collected into a clean stainless steel bowl and then transferred to the appropriate sample containers. One equipment rinsate blank will be collected for each sampling device associated with the ground water samples. The equipment rinsate blanks will be analyzed for identical parameters as the samples. Because dedicated bailers will be utilized for ground water sampling, the equipment blanks will be collected for dissolved metals analyses only, and will consist of ultrapure deionized water through the Millipore® filtration apparatus.

- Duplicates (Blind) - Blind duplicate samples will be collected to evaluate overall laboratory and field precision. One blind duplicate sample will be submitted to the laboratory at a frequency of 1:10 samples for each sample media for identical parameters as the associated environmental sample. Field duplicate analysis precision will be determined by comparison of the analytical results for each of the two samples and calculation of the relative percent difference (RPD) between the positive analytical results detected for the specified parameters;
- Quality Assurance (Split) Samples - Quality Assurance (QA) samples will be collected to evaluate overall laboratory and field precision and accuracy. One QA sample will be submitted to the USACE Quality Assurance laboratory at a frequency of 1:10 samples for each sample media for identical parameters as the associated environmental sample. QA sample results will be compared to the analytical results provided by LLI and MSAI and used by USACE to evaluate sampling and analysis performance; and
- Matrix Spike Sample - Matrix spike/matrix spike duplicate (MS/MSD) samples will also be submitted as further QC checks. These samples will be spiked by the laboratory. These will be collected at the frequency of one MS and MSD for every twenty field samples (including trip blanks, field blanks, and blind duplicates). These will allow accuracy to be determined by the recovery rates of compounds (the matrix spike and/or surrogate spike compounds defined in the analytical methods). Precision will also be assessed by comparison of matrix spike and matrix spike duplicate recoveries. The purpose of these laboratory spikes is to monitor any possible matrix effects specific to samples collected from the site. The addition of known concentrations of compounds/constituents into the sample also monitors extraction/digestion efficiency.

Matrix spike/matrix spike duplicate sample aliquots for solid/soil analyses will be split from the designated sample at the laboratory. The laboratory will select aliquots that are as homogeneous with respect to one another as possible to avoid precision problems related to sample in-homogeneity. The specific sample locations which will be sampled for matrix spike and blind duplicate analyses will be chosen by the Field Operations Manager with direction from the Quality Assurance Manager.

9.3 *ON-SITE ANALYTICAL FACILITY QUALITY CONTROL CHECKS*

Quality Control Checks for the On-site Analytical Facility are presented in Attachment 2.

10.0 PERFORMANCE AND SYSTEMS AUDITS

10.1 ON-SITE AUDIT

Two on-site systems field audits will be performed during both a soil and a ground water sampling event to review all field-related quality assurance activities. The system audits will be administered by ERM's Quality Assurance Manager. Figure 10-1 presents ERM's Quality Assurance Audit forms. The acceptance criteria for the field audit will be in adherence to the protocols presented throughout the QAPP. Deficiencies found during the audits will be brought to the attention of the responsible individuals and corrective action as per Section 13.0 of this QAPP will be initiated. Copies of the audits will be distributed to all project personnel and to the client.

Specific elements of the on-site audit include the verification of the following:

- Completeness and accuracy of sample Chain-of-Custody forms, including documentation of times, dates, transaction descriptions, and signatures;
- Completeness and accuracy of sample identification labels, including notation of time, date, location, type of sample, person collecting sample, preservation method used, and type of testing required;
- Completeness and accuracy of field notebooks, including documentation of times, dates, drillers' names, sampling methods used, sampling locations, number of samples collected, name of person collecting samples, types of samples, results of field measurements, soil logs, and any problems encountered during sampling;
- Adherence to health and safety guidelines outlined in the Site Health and Safety Plan including wearing of proper protective clothing;
- Adherence to decontamination procedures outlined in Section 4.0 of the Work Plan, including proper documentation of pumps and pump tubing, bailers, and sampling equipment; and
- Adherence to sample collection, preparation, preservation, and storage procedures.

10.2 LABORATORY AUDIT

10.2.1 Internal Laboratory Audits

Lancaster Laboratories, Inc. and Mountain States Analytical, Inc. (LLI and MSAI) performs regular systems and performance audits, and these are described in Attachment 1. LLI and MSAI systems and performance audits are discussed in Attachment 1.

10.2.2 ERM's Performance Audit of LLI and MSAI

On-site audits of LLI and MSAI will be performed by ERM's Quality Assurance Manager while Middletown samples are in-house to ensure adherence to the QAPP.

Results of the evaluation of both the field and laboratory audits will be submitted to ERM's Project Manager for review. If the results of the audit necessitate further action, the Project Manager will be notified of such and will be apprised of any corrective action taken.

10.3 ON-SITE ANALYTICAL FACILITY PERFORMANCE AND SYSTEMS AUDITS

On-site Analytical Facility performance and system audits are described in Attachment 2.

Figure 10-1 ERM Quality Assurance Audit Form

Project:_____ WO Number:_____

Date:_____

Auditor(s):_____

_____

On-Site Sampling Personnel:_____

_____

Audit Conducted on the following:

☐ Soil Sampling ☐ Surface Water/Sediment

☐ Ground Water ☐ Decontamination

Y = Yes N = No N/A = Not Applicable N/D = Not Determined

Sample Collection:

Do sampling locations agree with those specified in the Work Plan/Sampling Plan? _____

Is the sampling location either documented sufficiently or marked to allow it to be found/sampled again in the future? _____

Are sampling times, ERM Traffic Report Numbers and sample description noted in the FNB? _____

Is sampling proceeding from the suspected least contaminated area to the most contaminated area? _____

Have all field measurements been properly taken as per Sampling Plan? _____

Are field measurement(s) being taken immediately after the sample is collected? _____

Have sample bottles been labeled properly? _____

Have proper containers and preservatives been used? _____

Are proper sample volumes procured? _____

Does the potential for sample cross-contamination exist based on procedures observed? _____

Have MS and MSD(s) been collected as per QA/QC Plan? _____

Does a travel blank exist for each matrix present? _____

Are samples being refrigerated/iced immediately after collection? _____

Has condition of sample been recorded in the FNB and in the traffic report? _____

Have legal seal(s) been properly filled out and attached to the shipping container(s)? _____

Figure 10-1 Continued

Soil Sampling (Check if not applicable): ☐

Type: _____ ***Hand:*** _____ ***Auger or Rig-Backhoe Pit***

Are samples being collected at proper depths? _____

Are samples being screened with an OVA (if specified in Work Plan and applicable)? _____

Is a description of soils/materials being logged? _____

Have soils been homogenized where applicable (Specified by the Sampling Plan)? _____

Surface Water/Sediment Sampling (check if not applicable): ☐

Have stream flow and velocity parameters been noted? _____

☐ Estimated or ☐ Measured

Has sampling proceeded from downstream to upstream locations? _____

Has the sampler acquired the water sample upstream of his position to minimize suspended sediment from entering the sample? _____

Have water samples been collected in the mixing zone, not stagnant areas? _____

Have sediments been characterized as to type and size distribution? _____

Has the proper sediment fraction (fine, depth) been sampled for the analyses of interest? _____

Ground Water Sampling (Check if not applicable): ☐

Have organic vapor readings been obtained when the well head was opened? _____

Have depth to water level readings been taken for all wells? _____

Have the well specifications been noted properly (i.e., total depth, casing diameter, depth-to-water to the nearest one-hundredth of a foot, etc.)? _____

Has the purge volume been calculated properly? _____

Has well yield been properly evaluated to determine when sample acquisition should take place (i.e., does well go dry and need to recover)? _____

Has the purge pump been placed at the proper level to ensure proper well evacuation? _____

Figure 10-1 Continued

What evacuation method has been used? _____

☐ Bailer ☐ Submersible ☐ Other_____

☐ Bladder Pump ☐ Centrifugal Pump ☐ Foltz Pump

If metals are being analyzed, have the samples been field filtered? _____

Are field pH, conductivity, and temperature being measured and documented? _____

Is there documentation of calibrating the instruments? _____

Are bailer bags marked as to site name, well ID, and date of dedication? _____

Is bailer line and bailer dedicated to each well and line disposed of after use? _____

Bailer Type_____ Line Type_____

Have appropriate measures been taken to dispose of contaminated purge water, pump lines, bailers, etc.? _____

For Domestic Wells - Has as much information as possible on the well and distribution system been obtained (i.e., depth, casing type, diameter, treatment present, etc.)? _____

Has the sample been collected prior to treatment and as close to the well head as possible? _____

Has the domestic well been purged sufficiently to reach pH, conductivity, and temperature stabilization? _____

Have any fixtures been removed from the domestic well before the sample was taken? _____

Decontamination:

Has sampling equipment been decontaminated properly for the given analytes as per QA Plan? _____

Have the proper decontamination solutions been used? _____

For large equipment (backhoes, drill rigs), has decontamination taken place in an appropriate area? _____

Has decontamination water/solution been collected for proper disposal? _____

Where disposed?_____

Figure 10-1 Continued

Has disposable equipment, that is contaminated, been properly deconned and disposed of? _____

Have decon samples been taken from the sampling equipment as per Sampling Plan? _____

Has all appropriate information been recorded in the FNB? _____

Have the weather conditions been recorded? _____

Are weather conditions affecting sample quality? _____

Is the "Chain of Custody" being maintained for the samples? _____

Have all personnel been properly trained to operate the equipment present? _____

Are the objectives of the sampling activities understood by the field personnel? _____

Are employees conducting the investigation in a professional manner? _____

Audit Summary and Comments:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Signed by:

Sampler: _____ Print Name: _____

_____ _____

Auditor: _____ _____

_____ _____

11.0 PREVENTIVE MAINTENANCE

11.1 LABORATORY MAINTENANCE

LLI and MSAI's laboratory preventive maintenance programs and requirements are described in Attachment 1.

11.2 FIELD MAINTENANCE

ERM's field equipment is maintained through the use of a tracking system incorporating the tagging of each equipment item. This tag identifies its most recent maintenance, battery charge, and condition. When damaged equipment in need of repair is returned to the equipment warehouse, it is appropriately flagged for the required maintenance to be performed. This process ensures that only operable and maintained equipment enters the field. Routine daily maintenance procedures conducted in the field will include the following:

- Removal of surface dirt and debris from exposed surfaces of the sampling equipment and measurement systems will be performed using a non-abrasive cloth;
- Storage of equipment away from the elements within field vehicles or motel rooms;
- Daily inspections of sampling equipment and measurement systems for possible problems (e.g., cracked or clogged lines or tubing or weak batteries);
- Check instrument calibrations, as described in Section 6.2 of this QAPP; and
- Charging any battery packs for equipment when not in use within motel rooms.

Spare and replacement parts stored in the field to minimize downtime include the following:

- Appropriately sized batteries;
- Locks;
- Extra sample containers and preservatives;

- OVA igniters and filters;
- OVA H_2 gas, battery charger, and support equipment;
- Extra samples coolers, packing material, and sample location stakes;
- Additional supply of health and safety equipment, i.e., respirator cartridges, boots, gloves, tyvek, etc.; and
- Additional equipment as necessary for the field tasks.

11.3 ON-SITE ANALYTICAL FACILITY MAINTENANCE

On-site Analytical Facility performance and system audits are described in Attachment 2.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

12.1 OVERALL PROJECT ASSESSMENT

Overall data quality will be assessed by a thorough understanding of the data quality objectives which are stated during the design phase of the investigation. By maintaining thorough documentation of all decisions made during each phase of sampling, performing field and laboratory audits, thoroughly reviewing (validating) the analytical data as it is generated by the laboratory, and providing appropriate feedback as problems arise in the field or at the laboratory, ERM will closely monitor data accuracy, precision, and completeness.

12.2 FIELD QUALITY ASSESSMENT

To ensure that all field data are collected accurately and correctly, specific written instructions will be issued to all personnel involved in field data acquisition by the ERM Project Manager. The Quality Assurance Manager will perform field audits during the initial sampling events of the investigation to document that the appropriate procedures are being followed for sample (and blank) collection. These audits will include a thorough review of the field books used by the project personnel to ensure that all tasks were performed as specified in the instructions. The field audits will necessarily enable the data quality to be assessed with regard to the field operations.

The evaluation (data review) of travel blanks and other field QC samples will provide definitive indications of the data quality. If a problem arises which can be isolated, corrective actions can be instituted for future field efforts.

12.3 LABORATORY DATA QUALITY ASSESSMENT

Specific measures that will be taken by LLI and MSAI to assess data quality are presented in Attachment 1.

12.4 ERM'S LABORATORY DATA ASSESSMENT

12.4.1 ERM Data Validation

Data generated for ten percent of the samples collected during the investigation will undergo a rigorous ERM data review. This review will be performed in accordance with the most current "Laboratory Data Validation Functional Guidelines for the Evaluation of Organic (and Inorganic) Analysis" (USEPA Data Review Work Group, 6/91 for Organics and 7/88 for Inorganics). The remaining sample data will only be evaluated based on the results of associated blanks.

A preliminary review will be performed to verify that all necessary paperwork (chain-of-custodies, traffic reports, analytical reports, laboratory personnel signatures) and deliverables as stated in the Table 8-1 are present.

A detailed quality assurance review will be performed by the ERM Quality Assurance/Laboratory Coordinator to verify the qualitative and quantitative reliability of the data as it is presented. This review will include a detailed review and interpretation of all data generated by LLI and MSAI. The primary tools which will be used by experienced data review chemists will be guidance documents, established (contractual) criteria, and professional judgment. Table 12-1 presents the items examined during the quality assurance review.

Based upon the review of the analytical data, an organic and inorganic quality assurance report will be prepared which will state in a technical, yet "user friendly" fashion the qualitative and quantitative reliability of the analytical data. The report will consist of a general introduction section, followed by qualifying statements that should be taken into consideration for the analytical results to best be utilized. Based upon the quality assurance review, qualifier codes will be placed next to specific sample results on the sample data tables. These qualifier codes will serve as an indication of the qualitative and quantitative reliability of the data.

During the course of the data review, an organic and inorganic support documentation package is prepared which will provide the backup information that will accompany all qualifying statements presented in the quality assurance review.

Once the review has been completed, the Quality Assurance Manager will verify the accuracy of the review and will then submit these data to the

Project Manager. These approved data tables and quality assurance reviews will be signed and dated by the Quality Assurance Manager.

12.5 *DATA MANAGEMENT QUALITY ASSESSMENT*

As the analytical data generated from the subject investigation are validated, qualified, and submitted to the Project Manager, the quality of the data will be assessed from an overall management perspective by direct comparison of analytical results obtained from previous samplings. Information that can be obtained includes comparison of results obtained from samples taken within the same general vicinity, and the identification of missing data points. By examination of the data at the "back-end" of the process, the data quality can be assessed with respect to representativeness, precision, compatibility, and completeness.

12.6 *ON-SITE ANALYTICAL FACILITY DATA QUALITY ASSESSMENT*

On-Site Analytical Facility data quality assessment procedures are described in Attachment 2.

Table 12-1 Items Reviewed During the ERM Data Validation

Area Examined	Applicability (organic, inorganic, both)
ERM and Laboratory Chain of Custodies	Both
(Traffic Reports, Field Notes, etc.)	
Holding Times	Both
Extraction/Digestion Logs	Both
Blanks - field and laboratory (accuracy)	Both
Instrument Tune	Organic
Standards	Both
Linearity	Both
Sensitivity/Stability	Both
Selectivity/Specificity	Both
EPA Criteria (SPCC & LCS)	Both
Variability of Technique	
(internal standards)	Organic
Analyte Breakdown	Both
Analytical Sequence	Both
ICP Interference	Inorganic
Control Standards	Both
Samples	
Detection Limits	Both
Instrument Printouts	Both
ICP data	Inorganic
AA data	Inorganic
GC data	Organic
GG/MS data	Organic
Autoanalyzer data	Inorganic
Qualitative Identification	Both
Mass spectra	
Pesticide/PCB results	
Tentatively identified compounds	
Quantitative Reliability	Both
Calculations/Equations	Both
Matrix spikes (accuracy)	Both
Bias	

Table 12-1 Cont'd

Area Examined	Applicability (organic, inorganic, both)
Matrix spike duplicates	Organic
Bias	
Accuracy & Precision	
Surrogate Spikes	Organic
Bias	
Duplicates (field and laboratory)	Both
Precision	
Representativeness	
Post-Digestion Spikes	Inorganic
Matrix Effects	

13.0 CORRECTIVE ACTION PROCEDURES

13.1 LLI AND MSAI'S CORRECTIVE ACTION PROCEDURES

Corrective action procedures for LLI and MSAI are presented in Attachment 1. LLI and MSAI will provide documentation as to what, if any, corrective actions were initiated concerning the investigation and report them to ERM's Quality Assurance Manager.

13.2 ERM'S CORRECTIVE ACTION PROCEDURES

Field quality assurance activities will be reported periodically to ERM's Program Manager. Problems affecting quality assurance that are encountered during the study will be reported on a Corrective Action Form as presented in Figure 13-1. The Program Manager will report to the Quality Assurance/Laboratory Coordinator on all necessary corrective actions taken, the outcome of these actions, and their effect on data produced. All corrective action taken will be reported to USACE and to the ERM Project Manager.

Figure 13-1 Corrective Action Form

Date:_____

Job Name:_____

Initiator's Name and Title:_____

Problem Description:_____

Source of Defect:_____

Reported To:_____

Corrective Action:_____

Reviewed and Implemented By:_____

cc: Project Manager:_____

QA Manager:_____

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

14.1 DAILY QUALITY CONTROL REPORT

After project initiation, the ERM Project Manager, in conjunction with the Quality Assurance Manager, will submit Daily Quality Control Reports (DQCRs) to the USACE Project Manager. These reports will be compiled and submitted to the USACE Project Manager on a weekly basis. Should problems or deviations from the schedule occur, then the DQCRs will be forwarded daily to the USACE Project Manager. These reports will contain the following information:

- Date and Report Number,
- Location of the work (installation, site, boring, etc.),
- Weather and Field Conditions,
- Work Performed,
- Sampling Performed,
- Results of Field Measurements (Including Calibration Procedures and Results),
- Problems Encountered and Corrective Actions Taken,
- Quality Control Activities (Field and Laboratory),
- Verbal or Written Instructions From USACE Personnel,
- Names of Personnel On-Site,
- Equipment Used,
- Health and Safety Considerations,
- Deviations from the Work Plan, and
- Drill Logs Completed.

14.2 QUALITY CONTROL SUMMARY REPORT

The Quality Assurance Manager will be responsible for preparing a single Quality Control Summary Report (QCSR) for submittal to the Missouri River Division Laboratory. The QCSR will discuss data which should be

qualified as a result of field and/or laboratory quality issues, and their impact on the data quality objectives. The QCSR will include the following items:

- Project description,
- Sampling procedures,
- Summary of laboratory analytical methods, quantitation limits, quality control activities (field and laboratory),
- Evaluation of data quality,
- Recommendations for improving field or analytical procedures,
- DQCR Consolidation,
- Results of USACE Evaluation of QA Samples, and
- Conclusions.

Attachment 1
Lancaster Laboratories, Inc.
Mountain States Analytical, Inc.
Laboratory Quality Assurance Plan

Lancaster Laboratories, Inc.

Mountain States Analytical, Inc.

LABORATORY QUALITY ASSURANCE PLAN

MIDDLETOWN AIRFIELD

NPL SITE

FEBRUARY 16, 1994

1. Laboratory Quality Assurance Plan

This document provides the laboratory portion of the response to EPA's "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" QAMS-005/80, Sections 5.1 - 5.16 as revised December 29, 1980, and EPA-600/4-83-004, February 1983. Guidance was also obtained from "Preparation Aids for the Development of Category 1 Quality Assurance Project Plans," Office of Research and Development, USEPA, EPA/600/8-91/003, February 1991.

As much as possible, the procedures in this document have been standardized to make them applicable to all types of environmental monitoring and measurement projects. However, under certain site-specific conditions, all of the procedures discussed in this document may not be appropriate. In such cases it will be necessary to adapt the procedures to the specific conditions of the investigation.

Director of Quality Assurance: _____

3. Project Description

This quality assurance project plan provides specific quality assurance and quality control procedures involved in the generation of data of acceptable quality and completeness. Tests will be performed according to the analytical methodology set forth in the USEPA SW846 3rd Edition, Update 1, July 1992, and Chemical Analysis of Water and Wastes*. These methods provide specific analytical procedures to be used and define the specific application of these procedures. Proven instruments and techniques will be used to identify and measure the concentrations of volatiles, semivolatiles, and pesticide compounds and/or the inorganic elements. The laboratory will employ state-of-the-art GC/MS and/or GC procedures to perform all organic analyses, including all necessary preparation for analysis. Inorganic analyses will be performed using graphite furnace atomic absorption spectrophotometry (AA), inductively coupled plasma spectroscopy, or cold vapor AA. Wet Chemical analyses will use appropriate instrumentation. The client is responsible for providing specifics on the project site.

* Test Methods for Evaluating Solid Waste - Physical/Chemical Methods. SW846 (3rd Edition, Update 1, July 1992).

* Methods for Chemical Analysis of Water and Wastes, USEPA 600/4-79-020.

* Geochemical characteristic determinations will include ASTM methods.

4. Project Organization

The objectives of the laboratory Quality Assurance Program are to establish procedures which will ensure that data generated in the laboratory are within acceptable limits of accuracy and precision, to ensure that quality control measures are being carried out, and to ensure accountability of the data through sample and data management procedures. To this end, a Quality Assurance Department has been established. At Lancaster Laboratories, Inc. (LLI), the Director of Quality Assurance reports directly to the Executive Vice President of Laboratory Operations and has no direct responsibilities for data production, thus avoiding any conflict of interest. At Mountain States Analytical, Inc. (MSAI), the Director of Quality Assurance reports directly to the President of Laboratory Operations.

The attached organizational charts show the key personnel in both Corporate Services and Environmental Sciences for Lancaster Laboratories, Inc. and Mountain States Analytical, Inc. Resumes of key individuals may be found in the enclosed Qualification Manual and in this section.

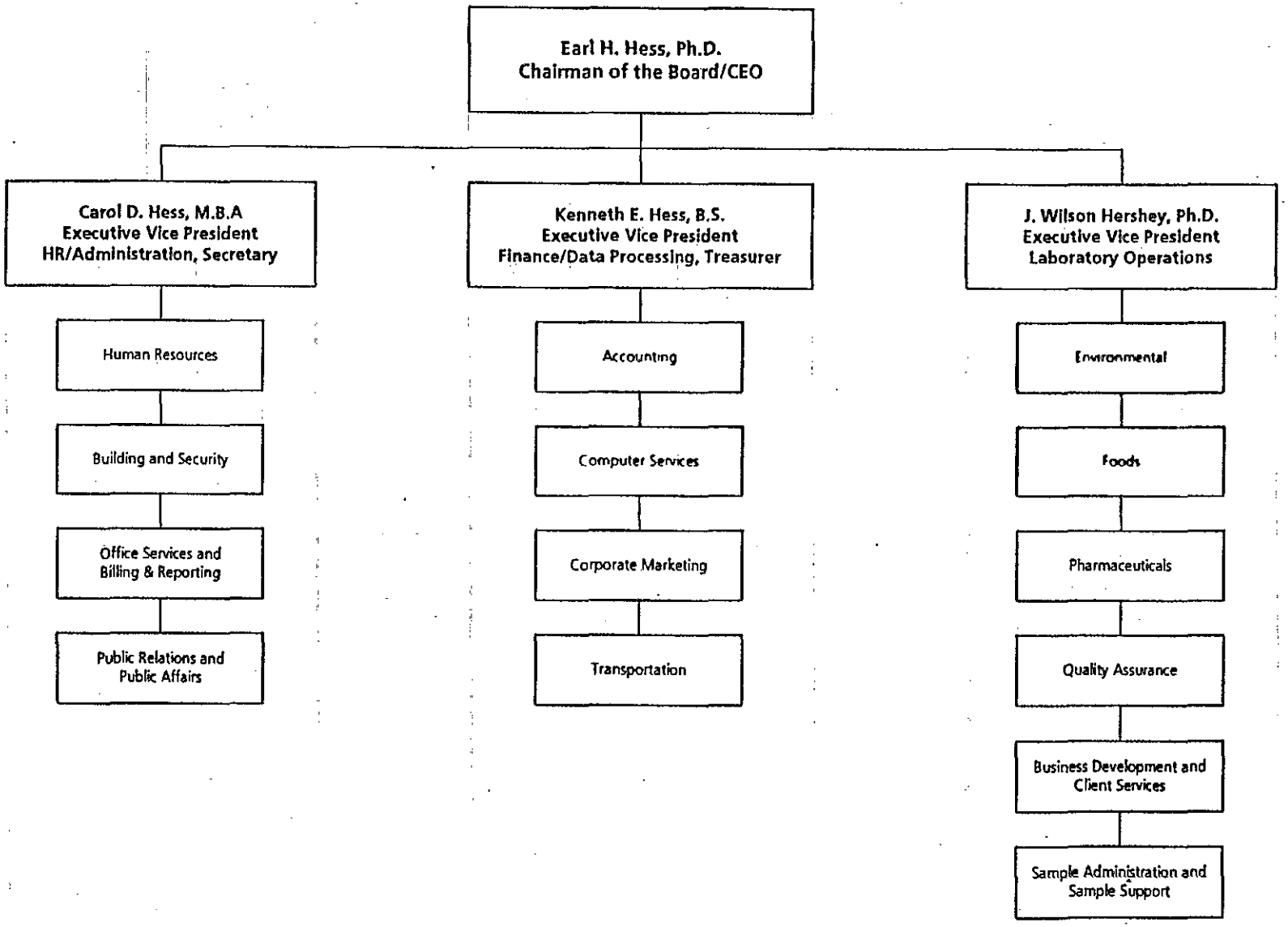
At Lancaster Laboratories, the Sample Administration Group will be responsible for receiving samples, signing the external chain-of-custody, checking sample condition, assigning unique laboratory sample identification numbers, and initiating internal chain-of-custody forms. Sample Support personnel will be responsible for assigning storage locations, checking and adjusting preservation, homogenizing the sample as needed, and sample discard. The Client Services Group is responsible for the above referenced tasks at Mountain States Analytical, Inc.

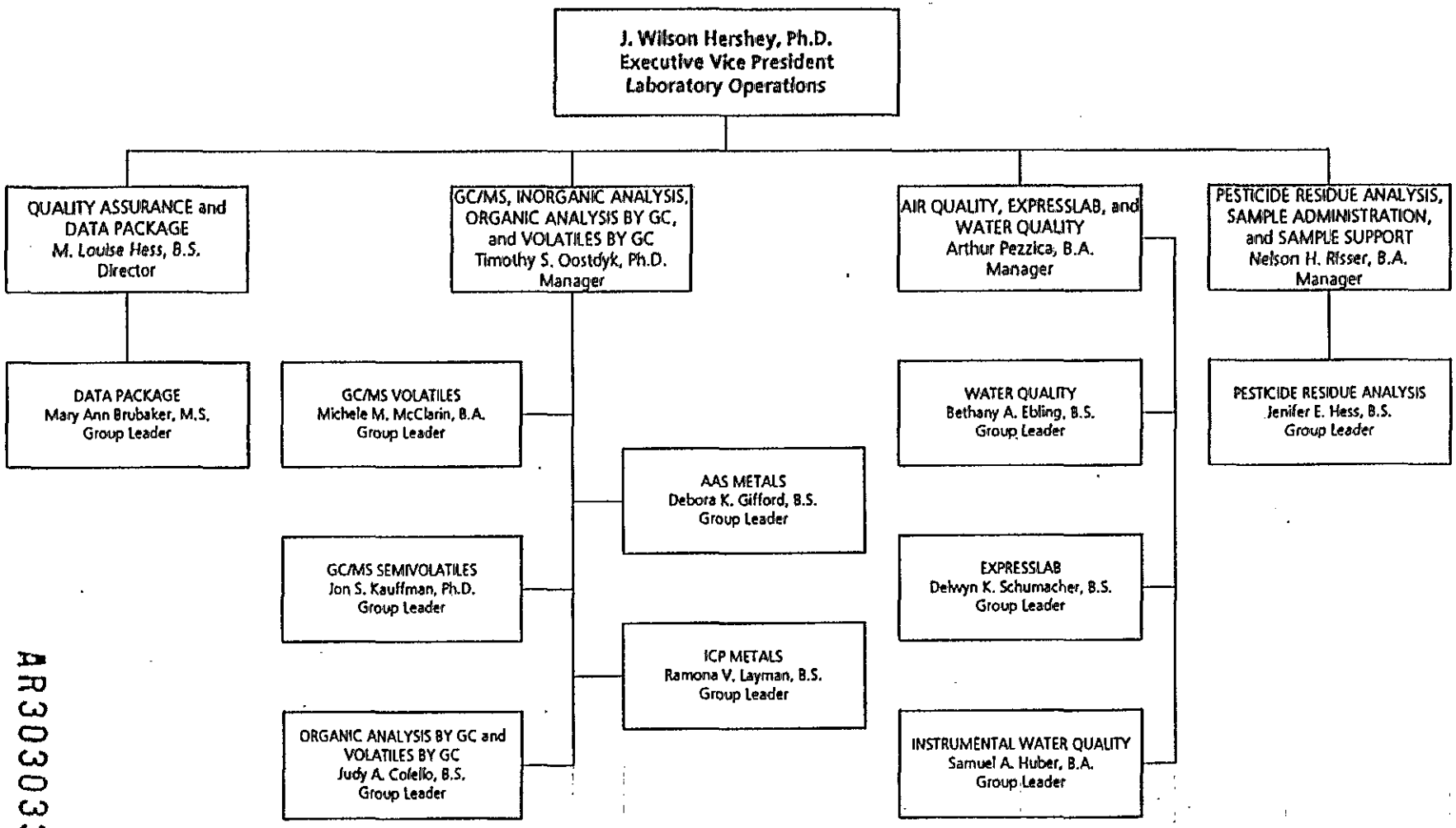
Group Leaders listed in each technical area are responsible for performing laboratory analyses, quality control as specified in the methods, instrument calibration, and technical data review. Data is reported using a computerized sample management system, which tracks sample progress through the laboratory and generates client reports when all analyses are complete. Quality control data is entered onto the same system for purposes of charting and monitoring data quality.

The Quality Assurance Department is responsible for reviewing quality control data, conducting audits in the laboratory and reporting findings to management, maintaining current copies of all analytical methods, maintaining copies of computer code used to calculate and report results, submitting blind samples to the laboratory, and ensuring that appropriate corrective action is taken when quality problems are observed.

Data package deliverables are available upon request. The Quality Assurance Department reviews the contents of the deliverables for completeness and to be sure that all quality control checks were performed and met specifications. This step includes review of holding times, calibrations, instrument tuning, blank results, duplicate results, matrix spike results, surrogate results, and laboratory control samples (where applicable). Every attempt to meet specifications will be made, and any item outside of the specifications will be noted in the narrative. The laboratory will not validate data with regard to useability since this generally requires specific knowledge about the site.

Laboratories
2425 New • Lancaster, PA 17601-5994

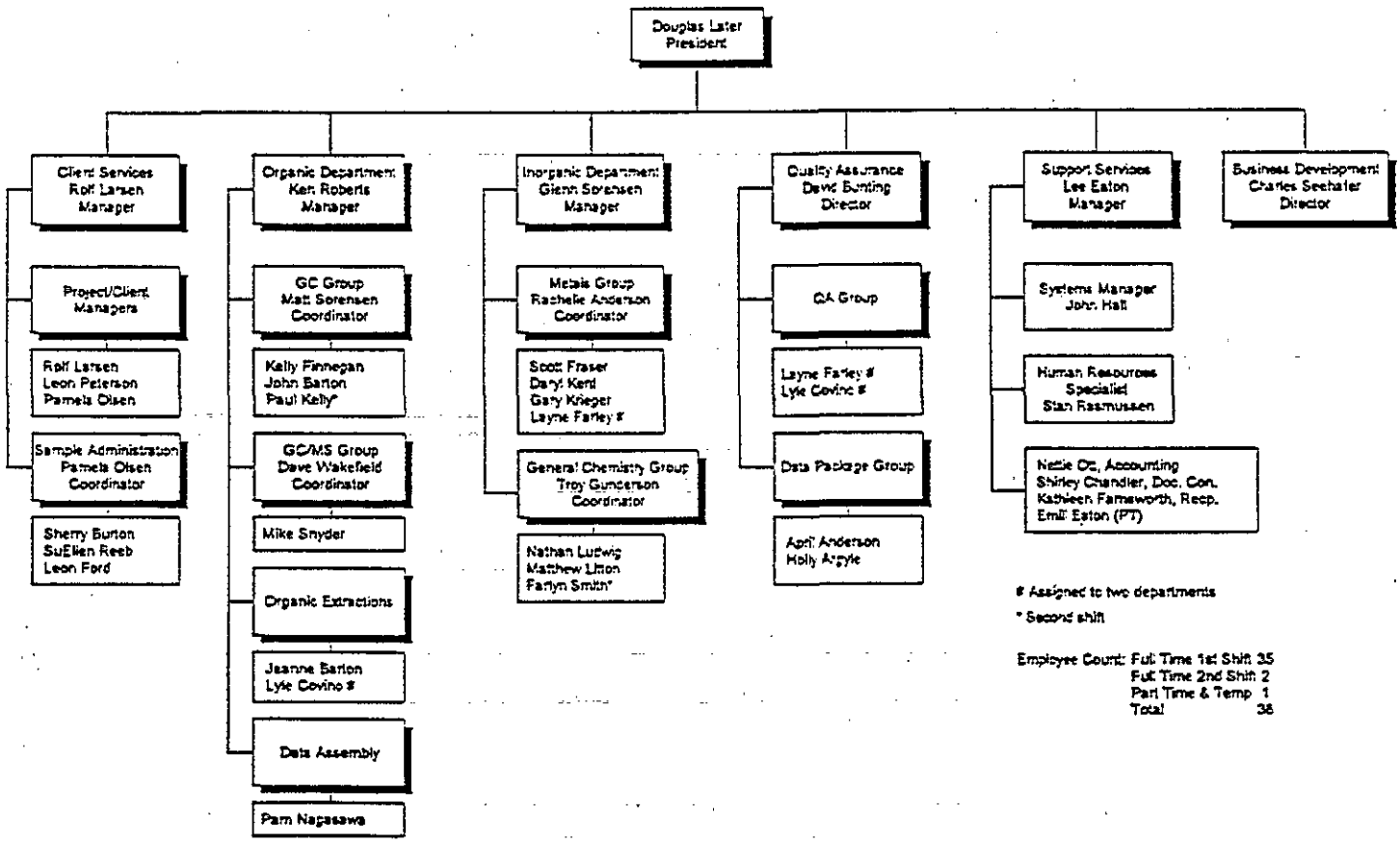



J. Wilson Hershey, Ph.D.
Executive Vice President
Laboratory Operations
QUALITY ASSURANCE and DATA PACKAGE
M. Louise Hess, B.S.
Director
GC/MS, INORGANIC ANALYSIS, ORGANIC ANALYSIS BY GC, and VOLATILES BY GC
Timothy S. Oostdyk, Ph.D.
Manager
AIR QUALITY, EXPRESSLAB, and WATER QUALITY
Arthur Pezzica, B.A.
Manager
PESTICIDE RESIDUE ANALYSIS, SAMPLE ADMINISTRATION, and SAMPLE SUPPORT
Nelson H. Risser, B.A.
Manager
DATA PACKAGE
Mary Ann Brubaker, M.S.
Group Leader
GC/MS VOLATILES
Michele M. McClarin, B.A.
Group Leader
AAS METALS
Debora K. Gifford, B.S.
Group Leader
GC/MS SEMIVOLATILES
Jon S. Kauffman, Ph.D.
Group Leader
ICP METALS
Ramona V. Layman, B.S.
Group Leader
ORGANIC ANALYSIS BY GC and VOLATILES BY GC
Judy A. Colello, B.S.
Group Leader
WATER QUALITY
Bethany A. Ebling, B.S.
Group Leader
EXPRESSLAB
Delwyn K. Schumacher, B.S.
Group Leader
INSTRUMENTAL WATER QUALITY
Samuel A. Huber, B.A.
Group Leader
PESTICIDE RESIDUE ANALYSIS
Jenifer E. Hess, B.S.
Group Leader

Mountain States Analytical, Inc.

Organization Chart

As of 12/07/93



The organization structure of Mountain States Analytical, Inc. is shown above. There are five main operating units: Client Services, Laboratory Operations (which includes the GC, GC/MS, Organic Extractions, Metals, and General Chemistry groups), Business Development, Quality Assurance, and Support Services.

Mountain States Analytical, Inc.

Douglas W. Later, Ph.D.

President

Professional Experience

Battelle Northwest Laboratories, 1982-1985
Research Scientist, Project Manager
Lee Scientific, 1985-1988
Vice President and Co-founder
Dionex, Lee Scientific Division, 1988-1989
Vice President, Marketing and Sales
Mountain States Analytical, Inc., since 1989
President and Laboratory Director

Continuing Education

Councilor Selling Series, Wilson Associates, 1984
Management Training, Western Leadership Group, Inc., 1986
Executive Excellence Series, Covey and Associates, 1987
Supercritical Fluid Chromatography and Extraction, ACS Short Course, 1988, Instructor

Education

Ph.D., Analytical Chemistry, Brigham Young University, 1982
B.A., Chemistry, Brigham Young University, 1978

Publications and Presentations

Approximately 150 publications and presentations in the field of analytical chemistry including 4 book chapters; 34 published proceedings; 13 government reports; 40 conference, seminar, and symposia presentations; and several journal publications.

Awards and Citations

John Einar Anderson Scholarship, 1979
Telford E. Wooley Cancer Research Award, 1981
Innovative Development Institute/Small Business Administration Small Business Innovative Research of the Year Award, 1988

Experience

Instrumental Analytical Chemistry
Microcolumn Chromatography
High Resolution Gas Chromatography
Supercritical Fluid Chromotography and Extraction
Chromatographic Detection Systems
Mass Spectrometry
Organic Analytical Chemistry
Polycyclic Aromatic Compound Chemistry
Coal and Fuel Chemistry
Environmental Chemistry
Industrial Applications of Supercritical Fluid Chromatography and Extraction

Mountain States Analytical, Inc.

Douglas W. Later. Ph.D.

(continued)

Memberships and Appointments

American Chemical Society, since 1979
- Fuel Chemistry Division, 1982-1989
- Analytical Chemistry/Chromatography Division, since 1987

Sigma Xi, 1981-1983

Association of Official Analytical Chemists, since 1989

International Committee on Polycyclic Aromatic Compounds, since 1984
- Executive Committee Member, since 1984
- Chromatography Subcommittee Chairman, 1984-1988

Brigham Young University, Chemistry Department
- Adjunct Faculty Appointment, 1985-1987

International Symposium on Polycyclic Aromatic Hydrocarbons
- Editorial Committee, since 1987

Journal of Polycyclic Aromatic Hydrocarbons
- Topical Editor, since 1988

The Journal of Microcolumn Separations
- Editorial Advisory Board, 1988-1989

American Council of Independent Laboratories, since 1989

Salt Lake City Chamber of Commerce, since 1989
- Environmental Issues Subcommittee, since 1990

Mountain States Analytical, Inc.

Rolf E. Larsen

Client Services Manager

Professional Experience
Huish Detergents, Inc., 1983-1991
Quality Assurance Manager
Mountain States Analytical, since 1992
Project Manager, 1992-1993

Education
B.A., Chemistry, University of Utah, 1982

Experience
Research and development: new product specifications, raw material research, performance testing, customer support
Developing safety programs, hazardous communications systems, and right-to-know information systems
TSCA, OSHA, CERCLA, and SARA Title III reporting requirements
Statistical quality control programs

Awards and Citations
Spirit of MSAI Award, Mountain States Analytical, 1993

Mountain States Analytical, Inc.

Kenneth A. Roberts

Organic Department Manager

Professional Experience

Auburn University, Chemistry Department, 1980-1981
Teaching Assistant
University of Utah, Chemistry Department, 1981-1982
Teaching Assistant
University of Utah, Chemistry Department, 1982-1987
Research Assistant
Center for Micro-Analysis and Reaction Chemistry, University of Utah, 1987-1989
Manager, GC/MS Analysis Lab
Mountain States Analytical, Inc., since 1989

Education

Graduate Studies, Organic Chemistry, University of Utah, 1981-1990
B.S., Chemistry, Auburn University, 1981
B.S., Building Technology, Auburn University, 1975

Publications and Presentations

Ten scientific publications in organic and analytical chemistry

Memberships and Appointments

American Chemical Society, since 1978

Experience

Synthetic Organic and Organometallic Chemistry
Mechanistic Studies of Organic Intermediates
Gas Chromatography
Gas Chromatography/Mass Spectrometry
High Performance Liquid Chromatography
Pyrolysis Mass Spectrometry
Infrared and UV Spectrometry
Nuclear Magnetic Resonance Spectrometry
Environmental Analyses

Mountain States Analytical, Inc.

Glenn A. Sorensen

Inorganic Department Manager

Professional Experience
Sunkist Growers Association, 1959-1962
Research Chemist
Hercules Incorporated, 1962-1970
Area Supervisor, Research Chemist
Bennett Paint Corporation, 1970-1987
Plant/Laboratory Manager
United States Pollution Control, Inc., 1987-1988
Laboratory Manager
Mountain States Analytical, Inc., since 1988

Continuing Education
Bomb Calorimeter, Leco Short Course, GC Analysis, Varian Course, 1987
Management Training, Grow Group, 1985
Instrumental Analysis, Utah Technical College, 1984-1985
Computer Science, Utah Technical College, 1985-1986
Atomic Absorption, Short Course, Perkin Elmer, 1982
Hazardous Materials Training, Grow Group, 1987
Safety Training, Hercules, 1963-1964
OSHA 40 Hour Sampling Course, 1986
First Aid Training Course, American Red Cross, 1987

Education
B.A., Chemistry, University of Utah, 1959
Minors—Mathematics and Physics

Publications and Presentations
Twenty scientific publications in organic and analytical chemistry

Awards and Citations
The Pauling Scholarship, 1955-1956
Leading Researcher, Sunkist, 1960
Employee of the Year, Bennett's Paint Corporation, 1986
Spirit of MSAI, Mountain States Analytical, 1990

Memberships and Appointments
American Chemical Society, 1962-1970

Experience
Plant Manager
Laboratory Manager
Monitoring Well Sampling
Monitoring Air Sampling
Environmental Analyses
Safety/Industrial Hygiene
TOX Analyzer
X-Ray Spectrometer
Gas Chromatography
Infrared Spectrophotometry
Atomic Absorption
Spectroscopy
Data Processing/Computers

Mountain States Analytical, Inc.

David H. Bunting

Quality Assurance Director

Professional Experience
Signetics Company, A Division of North American Philips Corporation
Laboratory Technician, 1979-1981
Technical Services Engineer, 1981-1985
QA/Chemistry Lab Supervisor, 1985-1992
Mountain States Analytical, since 1992

Continuing Education
Basic Ion Chromatography, Dionex, 1984
Flame AA, Graphite Furnace AA, ICP Short Course, Perkin Elmer, 1984
Pascal Programming, Brigham Young University, 1984
Crosby Quality College, Signetics adaptation, 1982, 1985, 1989
Supervisor Development, Blanchard Training and Development, 1987
Seven Basic Habits of Highly Effective People, Covey & Associates, 1988
C Programming, Utah Valley Community College, 1992
Weyant Communication Skills, 1992

Education
B.S., Chemical Engineering, Brigham Young University, 1982

Publications
One paper accepted for presentation at INTEREX conference, Orlando, FL, 1988.

Awards and Citations
Signetics Orem Plant Support Department Recognition Award, 1988
Giant Award, Mountain States Analytical, 1993

Memberships and Appointments
American Chemical Society, since 1988
American Institute of Chemical Engineers, 1978-1988
Semiconductor Equipment and Materials International (SEMI), Chemical Reagents Subcommittee, since 1987

Experience
Statistical Quality Control and Measurement Systems Evaluation
Quality Improvement Team Leader
Graphite Furnace AA, ICP
FTIR and UV/Vis Spectroscopy
Gas Chromatography
Ion Chromatography
Residual Gas Analyzer
Liquids Particle Counter
General Wet Chemistry
Computer Programming
Data Base Management
Instrument Design and Development

5. QA Objectives For Measurement Data

Quality Assurance is the overall program for assuring reliability of monitoring and measurement data. Quality control is the routine application of procedures for obtaining set standards of performance in the monitoring and measurement process. Data quality requirements are based on the intended use of the data, the measurement process, and the availability of resources. The quality of all data generated and processed during this investigation will be assessed for Precision, Accuracy, Representativeness, Comparability, and Completeness. These specifications will be met through precision and accuracy criteria as specified in Section 11. Detection limits are presented in Section 9.

Precision - Precision is determined by measuring the agreement among individual measurements of the same property, under similar conditions. The laboratory objective is to equal or exceed the precision demonstrated for the applied analytical method on comparable samples. The degree of agreement is expressed as the relative percent difference (RPD%). Evaluation of the RPD% is based on statistical evaluation of past lab data or guidelines within the methods for organic and inorganic analyses. External evaluation of precision is accomplished by analysis of Standard Reference Material and interlaboratory performance data.

Accuracy - Accuracy is a measure of the closeness of an individual measurement to the true or expected value. Analyzing a reference material of known concentration or reanalyzing a sample which has been spiked with a known concentration/amount is a way to determine accuracy. Accuracy is expressed as a percent recovery (%R). Evaluation of the %R is based on statistical evaluation of past lab data or guidelines within the methods for organic and inorganic analyses.

Representativeness - Representativeness expresses the degree to which data accurately represents the media and conditions being measured. The representativeness of the data from the sampling site will depend on the sampling procedure. Sample collection is the responsibility of the client. Samples will be homogenized, if required, as part of the laboratory sample preparation. By comparing the quality control data for the samples against other data for similar samples analyzed at the same time, representativeness can be determined for this objective.

Comparability - Comparability conveys the confidence with which one set of data can be compared to another. The analytical results can be compared to other laboratories by using traceable standards and standard methodology and consistent reporting units. The Laboratory Quality Assurance Program documents internal performance, and the interlaboratory studies document performance compared to other laboratories.

Completeness - Completeness is a measure of the quantity of valid data acquired from a measurement process compared to the amount that was expected to be acquired under the measurement conditions. The completeness of an analysis can be documented by including in the data deliverables sufficient information to allow the data user to assess the quality of the results. Additional information will be stored in the laboratories archives, both hard copy and magnetic tape. Quality Assurance Standard Operating Procedures (SOPs) are in place to provide traceability of all reported results.

To ensure attainment of the quality assurance objectives, Standard Operating Procedures (SOPs) are in place detailing the requirements for the correct performance of laboratory procedures. The laboratory SOPs fall under five general categories:

1. Corporate Policy
2. Quality Assurance
3. Sample Administration
4. General Laboratory Procedures
5. Analytical (i.e., methods, standard preps., instrumentation)

All SOPs are approved by the QA Department prior to implementation. The distribution of current SOPs and archiving of outdated ones are controlled through a master file. Table 5-1 provides an index of QA SOPs in place in support of the Quality Assurance Objectives. These requirements are supplemented by the procedures in the laboratory and analytical SOPs.

Table 5-1	
Document #	**Document Title**
QA-101	Sample Collection
QA-102	Sample Log-in
QA-103	Sample Storage and Disposal
QA-104	Chain-of-Custody Documentation
QA-105	Analytical Methods Manual
QA-106	Validation and Authorization of Analytical Methods
QA-107	Analytical Methods for Nonstandard Analyses
QA-108	Subcontracting to Other Laboratories
QA-109	Laboratory Notebooks and Documentation
QA-110	Reagents
QA-111	Instrument and Equipment Calibration
QA-112	Instrument and Equipment Maintenance
QA-113	Data Entry and Verification
QA-114	Data Storage and Security
QA-115	Quality Control Records
QA-116	Investigation and Corrective Action of Unacceptable Quality Control Data
QA-117	Personnel Training Records
QA-118	Quality Assurance Audits
QA-119	Proficiency Samples
QA-120	Documentation of Programming for the Sample Management System
QA-121	Guidelines for the Development, Validation, Implementation, and Maintenance of Computer Systems Used with CLP, GLP, and GMP Data

6. Sampling Procedures

In order for meaningful analytical data to be produced, the samples analyzed must be representative of the system from which they are drawn. It is the responsibility of the client to ensure that the samples are collected according to accepted or standard sampling methods.

The laboratory will provide the appropriate sample containers, required preservative, chain-of-custody forms, shipping containers, labels, and seals. The majority of sample containers are purchased precleaned by the supplier. Any reused bottles are cleaned in-house following laboratory Standard Operating Procedures. Special containers with traceability documentation are available upon request. Because the laboratory does not stock this type of container, one month prior notice is required.

Each lot of preservative will be documented and checked for contaminants before use. The appropriate bottle will be preserved with the new preservative and filled with deionized water to represent a sample. A similar container (that does not contain preservative) will be filled with deionized water to be used as a blank check. Analysis results are documented for each preservative lot number.

Trip blanks will be prepared by the laboratory and accompany sample containers at the project required frequency. Analyte-free water will also be provided for field blanks.

A list of containers, preservatives, and holding times follows in Table 6-1.

Table 6-1

Sample Containers, Preservatives, and Holding Times for Aqueous and Solid Samples

Fraction	Vol. Req. (ml) / Wt. Req. (g)	Container P=Plastic G=Glass	Preservation[a]	Holding Time[d] From Date of Collection Water	Soil
Volatiles	3 x 40 ml / 100 g	G	Cool, 4°C[b] pH <2 w/HCl	14 Days	14
Semivolatiles (Acid/Base Neutrals)	3 x 1000 ml / 100 g	G	Cool, 4°C[b]	7 Days to extraction[e]	14
Pesticides/ PCBs	2 x 1000 ml / 100 g	G	Cool, 4°C[b]	7 Days to extraction[e]	14
Metals	1000 ml / 100 g	P,G	HNO_3 to pH <2	6 Months Hg 38 days, G Hg 13 days, P	6
Cyanide	1000 ml / 100 g	P,G	Cool, 4°C NaOH to pH >12	14 Days	14
TOC	125 ml / 20 g	G	Cool, 4°C H_2SO_4 to pH <2	28 Days	28
Alkalinity	200 ml	P,G	Cool, 4°C	14 Days	
Hardness	100 ml	P,G	HNO_3 to pH <2	6 Months	
TDS	500 ml	P,G	Cool, 4°C	7 Days	
pH	50 ml / 50 g	P,G	Cool, 4°C	Immediately 14 Days	
Moisture	50 g	G	Cool, 4°C	NA	
Cation Exchange	100 g	G	Cool, 4°C	NA	
Grain Size	100 g[c]	G	Cool, 4°C	NA	

[a] pH Adjustment with acid/base is performed on water samples only.

[b] Sodium thiosulfate needed for chlorinated water samples

[c] A representative weight dependent on particle size

[d] Samples will be analyzed as soon as possible after collection. The times listed are the maximum times that samples will be held before analysis and still be considered valid.

[e] Analysis 40 days from extraction.

NOTE: For volatiles analysis, the container should be filled completely, with no headspace. **All sample containers, preservatives, and mailers will be supplied at no additional charge upon request, except for the special containers with traceability documentation. There is an additional charge for this type of container.**

7. Sample Custody

Samples are unpacked and inspected in the sample receipt area. At this time, the samples are examined for breakage and agreement with the associated client paperwork. The cooler temperatures will be checked upon receipt and recorded. As the samples are unpacked, the sample label information will be compared to the chain-of-custody record and any discrepancies or missing information will be documented. If necessary, the cooler will be closed and placed in cold storage until instructions and resolution of any discrepancies are received from the client.

A member of our Sample Administration Group will act as sample custodian for the project. To ensure accountability of our results, a unique identification number is assigned to each sample as soon as possible after receipt at the laboratory. When samples requiring preservation by either acid or base are received at the laboratory, the pH will be measured and documented, with the exception of samples designated for volatile analysis. Samples requiring refrigeration will be stored in our walk-in cooler which is maintained at 4° ± 2°C. The use of our computer system in tracking samples (by the laboratory sample number assignment) will control custody of the sample from receipt until the time of its disposal. The security system on our laboratory building allows us to designate the entire facility as a secure area. Therefore, hand-to-hand chain of custody is not part of our routine procedure, but is available upon request. If requested, hand-to-hand chain of custody will be provided as per attached LLI SOP-QA-104 and MSAI SOP-QA-103. The laboratory chain of custody will begin with the preparation of bottles. The procedures for sample log-in, storage, and chain-of-custody documentation are detailed in the QA Standard Operating Procedures included in

Section No. 7 (LLI SOP-QA-102, SOP-QA-103, SOP-QA-104 and MSAI SOP-QA-101, SOP-QA-102, SOP-QA-103). Examples of sample labels and custody seals are shown in Figures 7.1 and 7.2.

Figure 7.1

CLIENT

If you do not have an account with us, results will not be released until payment is received.

SAMPLE INDENTIFICATION / LOCATION CL. RES:

COLLECTION INFORMATION

☐ COMPOSITE
☐ GRAB

DATE TIME BY:

TESTING REQUIRED PRESERVATIVE(S) ADDED

Lancaster Laboratories
2425 New Holland Pike, Lancaster, PA 17601-5994

LLI#

Sample Label (Field)

LL# 1869683 DIS-000 26A 10/16/92

GRP-353016
EMP-210

00649-ABC MANUFACTURING, INC.
MW-4 GRAB WATER SAMPLE
SEMI-ANNUAL MONITORING PROTECT
COLLECTED ON 10/17/92 AT 1525 BY FRB
0219 0220 0516 1126

Sample Label (Laboratory)

Lancaster Laboratories
Where quality is a science

CUSTODY SEAL

2425 New Holland Pike, Lancaster, PA 17601-5994 (717) 656-2301

DATE:

SIGNATURE:

Laboratory Custody Seal

Figure 7.2

Mountain States Analytical
The Quality Solution
1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050 FAX (801) 972-6278

Client/Contact	W.O. P.O.
Site/Sample No.	Date
Analysis	Time
	Preservative

SPECIALTY CLEANED CONTAINER

Field Sample Label

3265 - 13851 (NV) A 1/ 1
#1 West Loc:AV-1
SxDT: 11/30/93 Mtx:SL

Laboratory Sample Label (Nonvolatile)

3265 - 13851 (V) A 1/ 1
#1 West Loc:AV-1
SxDT: 11/30/93 Mtx:SL

Laboratory Sample Label (Volatile)

CUSTODY SEAL

Person Collecting Sample _____ Sample No. _____
(signature)

Date Collected _____ Time Collected _____

Container Custody Seal

Lancaster Laboratories
Where quality is a science.

Initiated Date: 03/87
Effective Date: APR 14 1993

QUALITY ASSURANCE OPERATIONS MANUAL

SOP-QA-102

Title: Sample Log-in

Purpose:

In order to provide accountability of our results and to prevent sample loss or mix-up, a unique identification number is assigned to each sample.

Scope:

This SOP will cover the procedure used to log-in samples received for analysis.

Procedures:

1. All samples received by laboratory personnel shall be delivered to the Sample Administration Group immediately upon arrival at the laboratory. The only exception to this requirement will be samples which are not tracked using the computerized Sample Management System (SMS). There are only a few cases where samples will be not be tracked using the SMS. These include samples which will be stored for a long period of time prior to analysis, (e.g., stability storage) and samples for special projects that will be reported in a narrative R&D report instead of on the usual computerized analytical reports.

The procedures for sample log-in described in this SOP apply only to samples which are logged into the SMS. However, a written procedure for tracking any samples not entered into the SMS must be developed by the technical department responsible for the project or analysis of those samples.

2. All client correspondence relating to samples shall also be transferred to the Sample Administration Group. This includes purchase orders, quotes, letters and completed entry request forms.

3. Personnel of the Sample Support Group shall log the samples into the computer as soon as practical after receipt. The computer will assign a unique identification number to each sample. Samples shall be logged in on the same day they are received with the following exceptions:

   a. Samples received during a holiday or between 6 p.m. on Friday and 6 p.m. on Sunday. These samples shall be logged-in on the next normal work day.

   b. Samples submitted by clients without any indication of the tests to be performed or with unclear or incomplete information. Every effort shall be made to contact the client on the same day as sample receipt.

      If same day entry is not possible, any special storage requirements (e.g., refrigeration) should be observed.

4. Upon assignment of a sample number, the computer will generate a label which shall be attached to the sample container. The information on the label will include the LLI sample number, the client name, the storage location, a list of analyses requested (by analytical method number), a bottle code indicating container and preservative type, and a unique bar code.

5. Addition of preservatives to unpreserved samples will be the responsibility of the Sample Administration Group. Preservation should be performed immediately after log-in. A list of preservatives required for routine analyses may be found in the Fee Schedule.

6. All entries in preservation notebooks and on client paperwork shall be made in ink. The error correction procedure given in SOP-QA-109 shall be followed for any changes made in this documentation.

7. After samples are logged-in (or preserved, if required) they shall be stored in the computer-assigned location. If the computer-assigned location is inappropriate for the samples, the location code may be changed by manually overriding the computer.

8. The LLI sample number assigned to each sample shall be used to identify the sample in all records, including laboratory notebooks, instrument printouts, and

laboratory reports. The sample number shall be used to identify all additional containers of the sample which may be created during the sample preparation and analysis. This includes subsamples, extracts, and digestates.

SOPQA102.W51
SOP QA #1
032493

Prepared by: M Louise Hess Date: 4/8/93

Approved by: J Wilson Hershey Date: 4/8/93

Read and understood by: _____ Date: _____

Lancaster Laboratories
Where quality is a science.

Initiated Date: 03/87
Effective Date: JUL 3 0 1993

QUALITY ASSURANCE OPERATIONS MANUAL

SOP-QA-103

Title: Sample Storage and Disposal

Purpose:

Sample integrity can be compromised by improper storage conditions. The objective of these procedures is to prevent samples from deteriorating prior to analysis. The computerized sample management system (CSMS) is used to assign storage locations and to monitor the orderly storage of samples in locations from which they are easily retrieved for analysis or discard at the appropriate date.

Scope:

This SOP will outline procedures used in storing samples, retrieving and returning samples for analysis, and discarding samples when their holding time expires.

Procedures:

1. Personnel of the Sample Administration Group will designate the approximate size and type (e.g., refrigerator, freezer or room temperature) of sample storage required for each group of samples as they are logged onto the CSMS. The computer will assign the storage location and record the length of time the sample must be retained after the analysis report has been issued. Samples will be stored in the assigned

location. If the location is not suitable (e.g., insufficient space), the storage location may be changed using the manual override on the computer. If refrigerated space has been requested and all the computerized refrigerator locations are occupied, samples will be assigned locations in overflow refrigerators and will be tracked using a manual system until computerized locations are available.

2. Analysts requiring the use of a sample may determine its location by referring to the daily sample status sheet. There are varying degrees of security on sample storage locations. The procedures for removal of samples from these locations are as follows:

   a. Free access locations are those which are neither locked nor attended by a sample custodian. These areas are usually located within an individual group's laboratory and samples may be removed from and returned to these locations without documentation. However, if the sample must be taken out of the laboratory, documentation may be requested. Care shall be exercised in returning the sample to its appropriate location.

   b. Controlled access areas are attended by a sample custodian and are usually large areas used by more than one group. Samples stored in controlled access areas can be removed only after requisitioning the sample via the CSMS. The sample custodian will retrieve the requisitioned samples from the storage locations and scan the bar code label. This process

documents the sample transfer from the sample custodian to laboratory personnel. After use, the samples are returned to the sample storage center, scanned by the sample custodian and returned to the designated storage location. Only Sample Administration personnel shall be admitted to controlled access areas. The only exception to this rule will be during weekend hours when no sample custodians are on duty. During these hours, samples must be requisitioned as above, but analysts must retrieve the samples themselves, by obtaining a key to the controlled access area from the security desk. Samples must be scanned out as above. After use, samples must be scanned in and placed on the return cart inside WK. Sample custodians will return these samples to their location when they come on duty.

c. Locked storage areas are available in several individual lab areas. Access to these storage areas is limited to analysts who are responsible for the analysis of the samples stored there. These areas are locked when the laboratories are unattended and keys are available from members of the department where they are located. Samples are removed and returned as needed by analysts.

d. Forensic storage areas are locked and admission to these areas is only permitted to sample custodians. Most of the samples stored in these areas require strict chain-of-custody documentation as outlined in SOP QA-104, and should be requisitioned as described

in (b) above. Samples may not be removed or returned to these areas without signing chain-of-custody forms.

3. To prevent unnecessary deterioration of the samples, the aliquots needed for analysis shall be removed and the sample returned to storage with a minimum of delay.

4. The Sample Administration Group will generate a discard list of samples with retention dates that have expired. The retention dates are based upon client requirements or defaulted to a given number of days past the date when the report is generated, if no client requirements were given. These samples will be removed from storage by a member of the Sample Support Group or a member of the department responsible for the given storage location. Hazardous samples shall either be returned to clients, decontaminated or disposed of at the direction of supervisory personnel. Other samples will be discarded or returned to the client, if requested. Prior to discarding each sample, the bar code will be scanned to prevent discard of the wrong sample.

5. The temperature of each refrigerator or freezer used for storing samples or reagents requiring temperature control should be checked during each normal working day by an assigned member of the group responsible for the samples stored within and recorded on a log posted on the outside of the unit. Units containing samples requiring more complete documentation of storage conditions are monitored by use of a computerized recording device or a temperature wheel. Refrigerator

temperatures should be maintained at 4° ± 2°C and freezer temperatures should be maintained at -15° ± 5°C. If the temperature recorded does not fall within these ranges, the Maintenance Department should be contacted. Any repairs should be recorded and filed with the temperature log. All documentation of temperature checks and maintenance shall be kept in ink and any changes made shall follow the error correction procedure given in SOP-QA-109.

SOPQA103.W51
QA SOPs #1
071493

Prepared by: M Louise Hess Date: 7/23/93

Approved by: J. William Hensley Date: 7/23/93

Read and understood by: _____ Date: _____

Lancaster Laboratories
Where quality is a science.

Procedural Amendment #1

Number: SOP-QA-103

Title: Sample Storage and Disposal

Effective Date (listed on procedure): 07/30/93

Section(s) affected by change: Procedures

Reason for addition(s) or change(s): To allow flexibility for client-specified methods or protocols refrigeration requirements

Change will be effective from (date): 12/20/93

Samples or project affected: Project/samples with sample/standard storage temperature ranges other than those specified in this SOP.

List change(s) or addition(s) (specify which section):

Procedures:

Change third sentence in #5 to read as follows:

5. Refrigerator temperatures should be maintained at 4° ± 2°C and freezer temperatures should be maintained at -15° ± 5°C, unless otherwise specified in a client-supplied method or protocol.

SOPQA103.W60
QA SOP #1
122093

Prepared by: _____ Date: 12-20-93

Approved by: _____ Date: 12/20/93

Approved by: _____ Date: 12/21/93

Lancaster Laboratories
Where quality is a science.

Initiated Date: 03/87
Effective Date: DEC 3 0 1993

QUALITY ASSURANCE OPERATIONS MANUAL

SOP-QA-104

Title: Chain-of-Custody Documentation

Purpose:

In order to demonstrate reliability of data which may be used as evidence in a legal case or required by a regulatory agency, an accurate written record tracing the possession of the sample must be maintained from the time it is entered into the computer system until the last analysis is verified.

Scope:

Procedures for initiating and maintaining chain-of-custody (COC) documentation are described in this document.

Definition:

A sample is in custody if it is in any one of the following states:

1. In actual physical possession.
2. In view after being in physical possession.
3. Locked up so that no one can tamper with it.
4. In a secured area, restricted to authorized personnel. (e.g., in the ASRS system)

Procedures:

1. Chain-of-custody documentation shall be kept upon request of the client or for any samples which are known to be involved in a legal dispute. As with all analytical data, it is extremely important that documentation be filled out completely and accurately with every transfer. If changes to the form need to be made, the error correction procedure given in SOP-QA-109 shall be followed.

2. If requested by the client, the chain-of-custody documentation will begin with the preparation of bottles. A form (see Figure 1) will be initiated by the person packing the sample bottles for shipment to the client. If the delivery of bottles is via our Transportation Department, the driver shall sign the form when relinquishing the bottles. Drivers must also sign chain-of-custody forms when picking up samples which require such documentation.

3. When samples arrive at the laboratory, a member of the Sample Administration Group will receive them and sign the external chain-of-custody form, if one is provided with samples. If the sample was picked up by our Transportation Department, the driver must sign to indicate relinquishing the sample to Sample Receipt.

4. The Sample Administration group will track the custody of samples between receipt and entry into the computer on the SA Receipt Documentation log - Figure 3.

5. Samples will be logged into the computer as described in SOP-QA-102. Sample Administration personnel shall enter the analysis number for "laboratory chain of custody." A lab note to inform analysts of the need for chain of custody will be automatically added to sample labels.

6. Sample Administration personnel shall initiate an internal "Laboratory Chain-of-Custody" form (Figure 2) for each type of container in the sample group, and relinquish the samples to a sample custodian or designated key holder, who will store the samples in the assigned locked location. This change of custody from sample entry to storage shall be documented on the chain, as well as any interim exchanges for analysis, preservation, homogenization, or temporary hold storage. The internal chain-of-custody forms will then accompany the samples throughout the lab. A master list of chains started for each sample group should also be initiated at this time.

7. At this point, the original copy of the external client chain-of-custody will be filed with Accounts Receivable, to be returned to the client with the invoice. Other copies of the external COC (pink or yellow) will stay with the client's paperwork file.

8. All signatures documenting changes of custody will use the following format: first initial, full last name, and employee number. Dates will include month/day/year, and all time will be in military time. Black ink is preferred. Pencil or red ink is not acceptable. Figure 2 shows examples of chain-of-custody documentation.

9. Sample handling should be kept to a minimum. Analysts requiring use of a sample will requisition it through the computer requisition program. During the hours where Sample Support is manned by sample custodians, the custodian will receive the computerized requisition, and remove the sample from storage. The custodian will ensure that the bottle type listed on the chain of custody matches the bottle type being relinquished, then sign the "released by" column to indicate the sample has been relinquished, and fill in the date and time. The analyst shall sign the "received by" column and note the reason for change of custody before taking the samples to their work area. It will be a shared responsibility of technicians and sample custodians to ensure that forms are signed with each transfer.

10. All changes of custody must be documented on the form. The following changes of custody shall be handled as follows:

    a. Signatures involving transfers from one shift to another shall be the responsibility of the technician who originally acquired the sample from Sample Support. When samples are then returned to storage, the person returning the samples shall be responsible to sign the "released by" column, and to ensure that samples were properly received by the custodian with his/her signature in the "received by" column.

    b. Occasionally a sample container will be needed for analysis by a technician in a department while it has been signed out to a technician in another department. It will be the responsibility of the first technician who received the sample to see that

the second technician needing the sample signs the COC for receipt and return of the sample to the first technician.

c. In situations where a sample group must be split between departments working on different analyses, a supplemental chain of custody may be initiated by Sample Support. This supplemental chain will be used to accompany that portion of the group which is needed by a second department, when another department has part of the group and the chains of custody for the whole group. Initiating supplemental chains of custody may only be done by Sample Support and ExpressLAB, and should be used only when necessary to minimize paperwork and confusion. Sample Support will also document on a Masterlist, all chains and supplemental chains initiated for any sample group. This Masterlist of chains will be made available to Data Packages who collect all chains for packages.

d. Weekend work hours do not always have a sample custodian available. During these times the Lancaster Labs security personnel function as key holders to the storage areas. Technicians requiring use of samples over these times must requisition samples the previous day. These samples will be placed in the sample support hold walkin by a sample custodian. It will be necessary to page the security staff on weekends to acquire access to the hold walkin. Technicians may sign the COC for their own sample release by recording "SSG Storage" in the "Released By" column, and again in the "Received By" column when the sample is returned to the hold walkin.

e. Some samples are released by Sample Support and stored temporarily in other areas of the laboratory e.g. GC/MS Volatiles. During this time they may be worked on by several people in that department. Each of these people must sign for change of custody. These samples when completed are then returned to Sample Support. It will be the responsibility of the department who held temporary storage to see that all necessary signatures are on the chain of custody form before returning samples and forms, at the same time, to Sample Support. It is also important to return these sample groups as soon as possible after verification of data, because the chains may be required for data packages.

11. Analysts in possession of samples shall remove the aliquot required for analysis and return the sample to storage, as described in #12 below, with a minimum of delay. During the time of possession, samples must remain in the analyst's view or be in a designated storage area within a secure lab restricted to authorized personnel.

12. If additional containers of the sample are created (e.g., subsamples, extracts, distillates, leachates, etc.) an additional chain-of-custody form marked with container type may be initiated to accompany the new sample container. Each department in the lab has specifically designed chain-of-custody forms which shall be used for the new containers they create. All

changes of custody involving handling of new containers within the department (e.g., analysis, storage, vials on instruments, etc.) may be documented on the department specific chain or the original chain of custody. Any special handling or documentation requirements for department chains that are specific to any one department, should be described in a department SOP.

The only exception to the additional container form requirement will be for clients who specify chain of custody for the original sample only. In this case, no forms for sample preparation will be required.

After completion of new container sample analyses for department chains, the completed forms will be collected by the department's Data Package coordinator to be given to the Data Package department with the package data.

13. After analysis, samples shall be relinquished to a sample custodian who will return the samples to locked storage. The forms which remain in Sample Support shall be signed again to indicate storage, and the sample custodian will review the forms to ensure that all transfers are completely documented before filing the forms. Sample custodians will not return a sample to its storage location without signing an accompanying chain.

14. All completed forms for the original sample containers will be retained in files in Sample Support. The Data Package group will retrieve these forms to be copied for inclusion in the data packages. All original forms are either returned to the client or retained here, depending on the client's wishes.

15. All sample handlers in Sample Administration, Sample Support, and technical centers will make every attempt to ensure that all changes of custody are properly documented. Disciplinary action may be taken for employees who fail to comply with this important requirement.

16. In the event that a signature or other information is not recorded on the chain of custody, the Sample Support and Data Package groups shall determine what information is missing by checking computer requisition records, raw data, or Sample Support work schedules. The corrected information shall be added to the chain of custody and signed and dated with the current date of information entry. Any errors on chain-of-custody documentation shall be noted in the case narrative for the sample data package.

SOPQA104.W60
SOP QA #1
120793

Prepared by: _____ Date: 12/8/93

Approved by: _____ Date: 12/10/93

Approved by: _____ Date: 12/17/93

Read and understood by: _____ Date: _____

Analysis Request/Environmental Services Chain of Custody

Lancaster Laboratories
Where quality is a science.

For LLI Use Only
Acct. # _____ Sample # _____

Please print. Instructions on reverse side correspond with circled numbers.

(1) Client: _____ Acct. #: _____
Project Name/#: _____ PWSID #: _____
Project Manager: _____ P.O. #: _____
Sampler: _____ Quote #: _____
State where sample was collected: _____

(3) Matrix (4) | Total # of Containers | (5) Analyses Requested | For LLI use only: FSC: _____ SCR #: _____ | (6)

(2) Sample Identification	Date Collected	Time Collected	Matrix	Total # of Containers	Analyses Requested	Remarks	Preservation	Lab #

(7) **Turnaround Time Requested** (please circle): Normal Rush
(Rush TAT is subject to LLI approval and surcharge.)
Date results are needed: _____
Rush results requested by (please circle): Phone Fax
Phone #: _____
Fax #: _____

(8) **Data Package Options** (please circle if requested):
QC Summary
Tier I (NJ)
Tier II (NJ)
EPA CLP
GLP
Site-specific QC required? Yes No
(If yes, indicate QC sample and submit triplicate volume.)
Data Package Internal Chain of Custody required? Yes No

SDG Complete ? Yes No

(9) Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received for LLI by:	Date	Time

2425 New Holland Pike, Lancaster, PA 17601-5994 (717) 656-2301 Copies: White and yellow copies should accompany samples to Lancaster Laboratories. The pink copy should be retained by the client. 2/3/93 #2102

AR303070

Figure 1

Figure 2

Lancaster Laboratories

Locked Storage Chain of Custody

ORIGINAL SAMPLE

Client/Project: _____

Preservative: _____ Matrix: _____

Sample # Range of Entry Group: _____ Bottle Type:

SDG: _____

Sample Number(s)	Released by	Received by	Date	Time	Reason for Change of Custody

2016 Rev. 2/14/92

Lancaster Laboratories

Figure 3

Sample Administration Receipt Documentation Log

Client/Project: _____ COC Seal: Present / Not Present on cooler

Date of Receipt: _____ Broken / Intact

Time of Receipt: _____ Package: Chilled / Not Chilled

Source Code: _____ Unpacker Emp. No.: _____

Temperature of Samples		
#1	#2	#3
Thermometer ID: _____	Thermometer ID: _____	Thermometer ID: _____
Corrected Temp.: _____	Corrected Temp.: _____	Corrected Temp.: _____
Bottle / Air	Bottle / Air	Bottle / Air
Wet Ice / Ice Packs	Wet Ice / Ice Packs	Wet Ice / Ice Packs
#4	#5	#6
Thermometer ID: _____	Thermometer ID: _____	Thermometer ID: _____
Corrected Temp.: _____	Corrected Temp.: _____	Corrected Temp.: _____
Bottle / Air	Bottle / Air	Bottle / Air
Wet Ice / Ice Packs	Wet Ice / Ice Packs	Wet Ice / Ice Packs

Paperwork Discrepancy/Unpacking Problems: _____

Sample Administration Chain of Custody				
Released by	Received by	Date	Time	Reason for Transfer

Date Initiated: 8/90
Revision Date: 02/19/93

Mountain States Analytical

The Quality Solution

QUALITY ASSURANCE OPERATIONS MANUAL
STANDARD OPERATING PROCEDURE
QA-101

Title: Sample Log-In

Purpose:

When a sample is received at the laboratory, it is assigned a unique identification number. All containers are labeled with this number to prevent sample loss or mix-up and to provide accountability of analytical results.

Scope:

This SOP covers the procedures for assigning numbers and handling samples received for analysis.

Procedures:

1. All samples received by Sample Administration or laboratory personnel shall be delivered to the Sample Administration area immediately upon arrival at the laboratory. Sample Administration will be notified of their arrival.

2. Chain of custody forms shall be signed by the receiver after a general inspection of the sample shipment. A copy of the signed chain of custody form shall be provided to the client or delivery person.

3. All client correspondence relating to the samples shall be given to Sample Administration, including purchase orders, quotes, letters, chain of custody documents, project plans, and completed entry request forms.

4. All sample shipping containers, coolers, and sample kits shall be unpacked only when the samples are being logged in. Once logged in, samples should be transferred to a refrigerator immediately.

5. Sample Administration shall log the samples into the LIMS system as soon as possible. The computer will assign a unique identification number to each sample, and Sample Administration will assign a refrigerator location for each group of samples received. Samples shall be entered into the LIMS system as follows:

a. Sample shipments received before 4:00 p.m. shall be logged in on the same day.

b. Sample shipments received after 4:00 p.m. shall be refrigerated immediately, but may be logged in on the next working day.

c. Samples received after working hours (5:00 p.m.) shall be refrigerated immediately and logged in on the next working day, unless special arrangements have been made with the client.

d. In all cases, the samples shall be properly preserved without delay.

e. Samples submitted by clients with no indication of the *tests to be performed, or with incomplete or unclear* sample information, shall be contacted the same day (or as soon as possible) to obtain the information needed to complete the sample entry process. If same-day entry is not possible, the samples should be refrigerated until the information is obtained.

6. Sample Administration will generate from the LIMS system an analytical group report for each sample set which lists the samples and their assigned tests. The analytical group report will be filed in the group folder with any client correspondence relating to the samples.

7. The Department Managers will review the test assignments and any documentation submitted by the client to confirm that the tests on the analytical group report are accurate and complete. The Managers will then initial the group report. Sample Administration will double-check the entry information, then stamp [ENTERED] on the analytical group report and initial it after completing the sample entry process.

8. Upon assigning a sample number, the computer will generate labels which shall be affixed to each sample container. The label information will include the MSAI sample number, the client name, the storage location, and the discard date. Additional labels should be generated for sample tests that generate extracts or aliquot samples and should be attached to each container as it is stored in the refrigerator.

9. All samples will be checked for proper preservation. Analytical request forms submitted by the client should be checked to confirm that the samples have been properly preserved. Samples that require additional preservation will receive such treatment during the sample entry process. Preservation information should then be entered on the

analytical request forms. A list of preservatives required for routine analyses can be found in the Schedule of Fees and Services.

10. Samples with special instructions for analysis from the client will be tagged. It shall be the analyst's responsibility to consult Sample Administration for instructions.

11. After samples are entered into the LIMS system (and preserved if necessary), they shall be stored in the assigned refrigerator location. In most situations, only Sample Administration has access to the refrigerators.

12. Sample Administration will immediately prepare a backlog statement on all rush samples or samples requiring immediate analyses and will provide a copy to the appropriate Department Managers.

13. Clients shall be contacted regarding any sample that violates holding times or storage or shipping conditions as specified in the Schedule of Fees and Services. The client shall have the option of resubmitting a new sample or approving analysis of the submitted sample.

14. A log book shall be kept in Sample Administration to document any verbal instructions (in person or by telephone) from clients regarding changes, additions, or deletions to their samples or the requested analyses.

Prepared by: Carrie L. Ulrich Date 02/19/93

Approved by: David H. Bunting Date 02/19/93

Read and understood by: [signature] Date 02/14/94

Date Initiated: 12/89
Revision Date: 08/31/92

Mountain States Analytical

The Quality Solution

QUALITY ASSURANCE OPERATIONS MANUAL
STANDARD OPERATING PROCEDURE
QA-102

Title: Sample Storage and Disposal

Purpose:

The integrity of our analytical data must be insured by proper sample storage conditions. The objective of proper sample storage is to prevent sample deterioration prior to analysis. Sample Administration is responsible for assigning storage locations and monitoring the orderly storage of samples in locations from which they can easily be retrieved for analysis. Sample Administration is also responsible for making sure that samples are not discarded before the proper discard date and that the client has been contacted regarding the disposal of samples.

Scope:

This SOP covers procedures to be used for storing samples, retrieving and returning samples for analysis, and discarding samples when their holding time expires.

Procedures:

1. Sample Administration will determine the appropriate temperature and place (refrigerator or freezer) for sample storage for each group of samples as they are entered into the LIMS system. Sample groups will be assigned a specific storage location and will be stored in this location while in the custody of the laboratory. Separate designated refrigerators are used to store all samples for Volatile Organic Compound (VOC) analysis to avoid contamination.

2. The computer will assign discard dates based on default storage terms (typically 30 days) unless special holding or storage instructions are requested by the client.

3. Analysts requiring the use of a sample may determine its location by referring to the daily sample backlog status sheet or the analytical group report. The procedures for obtaining samples are as follows:

   a. Analysts must submit a Sample Requisition/Internal Traceability Worksheet to Sample Administration. The information required to fill out an SR/IT Worksheet can be found on the daily backlog or the analytical group report (see SOP SA-106).

   b. If the client has requested internal chain of custody documentation for its samples, the analyst must also sign the SR/IT Worksheet to show transfer of custody of the requested samples (see SOP QA-103). Any irregularities in these procedures should be reported directly to top management.

4. To prevent unnecessary deterioration of the samples, the aliquot needed for analysis shall be removed and the sample returned to Sample Administration immediately. All sample containers should be kept in their assigned location. Sample Administration will document unexpired empty sample containers prior to discarding them.

5. All samples shall either be returned to clients, decontaminated, neutralized, or disposed of under the direction of department managers according to procedures outlined in SOP LAB-101.

6. Sample Administration will print from the LIMS system a weekly list of samples for disposal. Clients shall be contacted on the discard date and will have three options:

   a. Retain the samples in storage for an additional period of time. A fee of $0.10/day or $3.00/month will be assessed for sample storage.

   b. Return samples to the client's custody for disposal or storage.

   c. Discard samples at Mountain States Analytical. Proper disposal of samples and storage in approved 55-gallon polyethylene-lined drums will be followed according to SOP LAB-101.

6. The temperature of each refrigerator or freezer used for storing samples will be checked daily and recorded in ink on log sheets posted on the storage units (see example following this SOP). Refrigerator temperatures should be maintained at 4C ± 2C and freezer temperatures at -15C ± 5C. If the temperature of a unit is observed to be outside these operating parameters, the procedures in SOP QA-120 should be followed immediately. Changes or corrections on temperature logs should be made according to the rules for corrections in SOP QA-108. Any maintenance or repairs should be recorded and filed with the temperature logs.

Prepared by: Carrie L. Ulrich Date 02/19/93

Approved by: David H. Fenting Date 02/19/93

Read and understood by: Douglas W. Yates Date 02/14/94

DAILY TEMPERATURE LOG

Storage Unit No. _____ Page No. _____

Control limits for refrigerators: 2°C to 6°C
Control limits for freezers: -10°C to -20°C

Date MM/DD/YY	Temp. in Degrees C	Temp in Limits? (✓ or No)	Reader Initials/ Time	Comments

If temperature falls outside control limits, notify Group Leader or QA Director immediately

Initiated Date: 02/90
Revision Date: 02/10/93

Mountain States Analytical

The Quality Solution

QUALITY ASSURANCE OPERATIONS MANUAL
STANDARD OPERATING PROCEDURE
QA-103

Title: Internal Chain of Custody Documentation

Purpose:

In order to demonstrate the reliability of our analytical data, an accurate written record tracing the possession of a sample from its receipt at the laboratory to its disposal must be maintained. This documentation may be required by a regulatory agency or used as evidence in a legal case.

Scope:

This SOP covers procedures for producing and maintaining internal chain of custody documentation and the procedures for handling external chain of custody documentation. Internal chain of custody procedures in this SOP require a separate form and greater security than the requisition procedure used for normal samples.

Definition:

A sample is in custody if it is:

1. In physical possession of an MSAI employee.
2. In view after being in physical possession.
3. Locked up so that no one can tamper with it.

Procedures:

1. External Chain of Custody

   a. If requested by the client, an external chain of custody form will be initiated by the person packing the sample bottles for shipment to the client. If the bottles are delivered by an MSAI driver, the driver shall sign the form when relinquishing the bottles. Drivers must also sign chain of custody forms when picking up samples that require such documentation.

b. When samples arrive at the laboratory, Sample Administration will inspect the samples, receive them, and sign the external chain of custody form, if one is provided with the samples. If the sample was picked up by an MSAI driver, the driver must sign to relinquish custody of the sample to Sample Administration.

c. Samples will be logged into the computer and be placed in secured storage as described in QA-101. The external chain of custody forms will be filed in the group folder.

2. Internal Chain of Custody

a. Internal chain of custody documentation shall be kept upon request of the client or for any samples that are known to be involved in a legal dispute.

b. When the samples are logged into the computer, Sample Administration shall inspect the samples, assign the samples to locked storage, and enter the analysis number for "Internal Chain of Custody," which will inform analysts of the need for chain of custody documentation.

c. Sample Administration will initiate an internal chain of custody form for each separate sample container. The internal chain of custody forms will accompany the sample containers. The samples and internal custody forms will then be stored in the assigned locked location.

d. Sample handling should be kept to a minimum. Analysts requiring use of a sample should contact Sample Administration, who will remove it from storage and sign the form to indicate change of custody. The analyst will sign the "Received by" column and note the reason for change of custody.

e. Analysts in possession of samples shall remove the aliquot required for analysis and return the sample to storage as described in paragraph f. as soon as possible. During the time of possession, samples must remain in the analyst's view or be locked up. All changes of custody shall be documented on the form. If additional containers of the sample are created (such as an extract container for preparation for organic analysis), an additional form marked with the container type shall be created to accompany the new container.

f. After analysis, samples shall be relinquished to Sample Administration, who will return the samples to locked storage. The forms that remain with the samples shall be signed again to indicate change of custody.

g. After all analyses are completed, the internal chain of custody forms will be placed in the group folder for inclusion with the analytical group report.

Prepared by: Carrie L. Ulrich Date 02/19/93

Approved by: David H. Buntin Date 02/19/93

Read and understood by: Douglas W. Late Date 02/14/93

Attachment 1

Mountain States Analytical

Nº 1694

Sample Chain of Custody

Client Name: _____ P O # _____

Phone #: _____ Fax #: _____

Project Name/#: _____

Sampler: _____

Sample Identification	Date Collected	Time Collected	Grab	Composite	Soil	Water	Other	Total of Containers	Analysis Required	Rush?	Remarks	Temp. of Samples Upon Receipt

Name of Shipper	Airbill No.	Date	Time	Sample relinquished by:	Date	Time	Sample received by:	Date	Time

Received By (Lab)	Date	Time	Seals Intact?

Turnaround Time Requested (please circle): Normal Rush
(Rush TAT is subject to MSAL approval and surcharge)

Report Results By: (Date) _____

Rush results requested by (please circle): Phone Fax

Report Results to: _____

_____

Type of Disposal:

Authorized for Disposal by:

Date/Time of Disposal:

Disposed of by:

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050 FAX (801) 972-6278

White Copy - Original Retain by Lab Yellow Copy - Return to Customer Pink Copy - Retain by Sampler

Attachment 2

Mountain States Analytical

The Quality Solution

INTERNAL CHAIN OF CUSTODY

Client Information
Name_____
Project_____
Sample ID/Desc._____

MSAI Information
Sample No._____
Group No._____
Storage Loc._____

Released by	Received by	Date/Time	Reason for change/analysis

All samples are stored at 4°C ± 2°. Supporting documentation available upon request.

This form has been designed to accompany individual samples from the moment they are entered into the computer until analyses are completed. Upon completion, this form will be placed in the group file.

MSAJ103B(Revised 01/93)

8. Calibration Procedures

Procedures for initial calibration and continuing calibration verification are in place for all instruments within the laboratory. The calibrations generally involve checking instrument response to standards for each target compound to be analyzed. The source and accuracy of standards used for this purpose are integral to obtaining the best quality data. Standards used at Lancaster Laboratories, Inc. (LLI) and Mountain States Analytical, Inc. (MSAI) are purchased from commercial supply houses either as neat compounds or as solutions with certified concentrations. The accuracy and quality of these purchased standards is verified through documentation provided by these commercial sources. Most solutions and all neat materials require subsequent dilution to an appropriate working range. All dilutions performed are documented and the resulting solution is checked by obtaining the instrument response of the new solution and comparing with the response to the solution currently in use. Any discrepancies between the responses are investigated and resolved before the new solution is used. Each standard is assigned a code which allows traceability to the original components. The standard container is marked with the code, name of solution, concentration, date prepared, expiration date, and the initials of the preparer. Shelf-life and storage conditions for standards are included in the standard operating procedures and old standards are replaced before their expiration date.

Each instrument is calibrated with a given frequency using one or more concentrations of the standard solution. As analysis proceeds, the calibration is checked for any unacceptable change in instrument response. If the calibration check verifies the initial response, the analysis proceeds. If the calibration check indicates that

a significant change in instrument response has occurred, then a new calibration is initiated. If necessary, maintenance may be performed prior to the recalibration.

Calibration records are usually kept in the form of raw data with the other instrument print-outs. In cases where no data system is used, calibration data is manually recorded in notebooks. Any maintenance or repair is also recorded in a notebook. The information recorded either in the notebooks or on the instrument print-out includes the date, instrument ID, employee name and/or identification number, and concentration or code number of standard.

The frequency of calibration and calibration verification, number of concentrations used, and acceptance criteria for each of the instruments to be used are listed on Table 8-1. In addition to checking the instrument response to target compounds, the GC/MS units are checked to ensure that standard mass spectral abundance criteria are met. Prior to each calibration, instruments being used for volatile compound analysis are tuned using bromofluorobenzene (BFB) and instruments being used for semivolatile analysis are tuned using decafluorotriphenylphosphine (DFTPP). The key ions and their abundance criteria are listed in Table 8-2.

Table 8-1

	Initial Calibration			Continuing Calibration Verification		
Instrument	Frequency	# Std Conc	Acceptance Criteria	Frequency	# Std Conc	Acceptance Criteria
GC/MS Volatiles	After C-cal fails	5	RF for SPCC's ≥0.300 except for bromoform ≥0.25. Max %RSD for CCC's ≤30%	Every 12 hours	1	RF for SPCC's ≥0.300 except for bromoform ≥0.25. Max %D for CCC's ≤25%
GC/MS Semivolatiles	After C-cal fails	5	RF for SPCC's ≥0.050. Max %RSD for CCC's ≤30%	Every 12 hours	1	RF for SPCC's ≥0.050. Max %D for CCC's ≤30%
GC Pesticides	Each new run After C-cal fails	5	≤20% RSD of RF's of initial calibration to use ave. RF, otherwise use curve fit. Degradation for DDT, endrin ≤20% initially	Every 10 samples	1	≤15% difference from initial response for quantitation, ≤20% difference for confirmation
PCBs Only	Each new run After C-cal fails	5 1242/ 1260 1 All others	≤20% RSD calc. on 3-5 peaks	Every 10 samples	1 1242/ 1260	≤15% difference from initial response for quantitation, ≤20% difference for confirmation
ICP	Each new run Max. 86 samples-run	2	Independent calibration verification within ±10%	Every 10 samples	1	Same as initial

Table 8-1

	Initial Calibration			Continuing Calibration Verification		
Instrument	Frequency	# Std Conc	Acceptance Criteria	Frequency	# Std Conc	Acceptance Criteria
CVAA	Each new run	5	Independent calibration verification within ±20%	Every 10 samples	1	Same as initial
GFAA	Each new run	5	Independent calibration verification within ±20%	Every 10 samples	1	Same as initial
Alpkem Autoanalyzer	Daily	6	Correlation coefficient >0.995	Every 10 samples	1	±10% of true value
Spectrophoto-meter	Daily	6	Correlation coefficient >0.995	Every 10 samples	1	±10% of true value
TOC Analyzer	Daily	5	±10% @ STD	Every 10 samples	1	±10% of true value
Balance	Daily	4	±.5%	N/A	N/A	N/A
pH Meter	Daily	Slope 2 Buffers	Independent calibration verification ±3%	Every 10 samples	1	±3%

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Abbreviations

Std Conc is the number of standard concentrations used. SPCC's are system performance check compounds. CCC's are calibration check compounds. RF is response factor.
%RSD is percent relative standard deviation. %D is percent difference.
C-cal is continuing calibration. CVAA is Cold Vapor Atomic Absorption Spectrophotometer.
ICP is Inductively Coupled Plasma Spectrophotometer; ICP run also includes interelement correction check standard (beginning and end of run).
GFAA is Graphite Furnace Atomic Absorption Spectrophotometer.

Table 8-2	
Mass	**Ion Abundance Criteria**
BFB Key Ion Abundance Criteria:	
50	15 to 40% of mass 95
75	30 to 60% of mass 95
95	base peak, 100% relative abudance
96	5 to 9% of mass 95
173	less than 2% of mass 174
174	greater than 50% of mass 95
175	5 to 9% of mass 174
176	greater than 95% but less than 101% of mass 174
177	5 to 9% of mass 176
DTFPP Key Ions and Ion Abundance Criteria:	
51	30 to 60% of mass 198
68	less than 2% of mass 69
69	mass 69 relative abundance
70	less than 2% of mass 69
127	40 to 60% of mass 198
197	less than 1% of mass 198
198	Base peak, 100% relative abundance
199	5 to 9% of mass 198
275	10 to 30% of mass 198
365	greater than 1% of mass 198
441	Present but less than mass 443
442	greater than 40% of mass 198
443	17 to 23% of mass 442

9. Analytical Procedures

The analytical procedures to be used for organics and inorganics are those described in the USEPA SW846 3rd Edition, 1986, for the preparation and analysis of water, sediment, and soil for the client specified compounds. Copies of the analytical procedures are located in the laboratory and available for use by analysts. Copies of analytical methods are available upon request.

Volatiles by GC/MS - This method determines the concentration of volatile (purgeable) organics. The analysis is based on purging the volatiles onto a Tenax/silica gel trap, desorbing the volatiles onto a gas chromatographic column which separates them and identifying the separated components with a mass spectrometer. Method 8260.

Semivolatiles - This method determines the concentration of semivolatile organic compounds that are separated into an organic solvent and are amenable to gas chromatography. The method involves solvent extraction of the sample to isolate analytes and GC/MS analysis to determine semivolatile compounds present in the sample. Method 3510A/3550/8270A.

Pesticides/PCBs - This method determines the concentration of organochloride pesticides and polychlorinated biphenyls. The procedure includes solvent extraction of the sample, analysis of the extract on a gas chromatograph/electron capture detector (GC/EC) using a megabore capillary column, and confirmation on a GC/EC using a second megabore capillary column. If the compound concentration is sufficient, confirmation may be done on GC/MS upon request. Pesticides Method 3510A/3550/8080.

Inductively Coupled Plasma (ICP) - This is a technique for the simultaneous determination of elements in solution after acid digestion. The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Characteristic atomic line emission spectra are produced by excitation of the sample in a radio frequency inductively coupled plasma. Because the temperature of the plasma is considerably higher, it is especially useful for refractory metals. Method 3005A/3010A/3050A/6010.

Graphite Furnace Atomic Absorption (GFAA) - This is a method of analysis designed to detect trace amounts of the analyte through electrothermal atomization. Samples are digested before analysis. The Graphite Furnace AA Spectrophotometer heats the sample within a graphite tube using an electrical current (ie flameless furnace) and measures the absorption of specific metallic elements at discrete wavelengths. Methods 3020A/3050A (see attached list for analysis method number.)

Cold Vapor Atomic Absorption - Organic mercury compounds are oxidized and the mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an AA spectrophotometer and absorbance (peak height) is measured. Method 7470/7471.

Total & Amenable Cyanide Analysis - Digestion and flash distillation of the sample aid in breaking down the complex cyanides to HCN. Simple cyanides are converted to cyanogen chloride by reaction with Chloramine T. This reacts with pyridine and barbituric acid reagent to give a red colored complex. The absorbance is read at 570 nm and is compared to a standard curve. Method 9010A (MSAI). An Alpkem Autoanalyzer is used for Method 9012 (LLI).

Moisture - A known sample weight is placed in a drying oven maintained at 103° to 105°C for 12 to 24 hours. The sample is reweighed after drying and this value is divided by the original weight. The result is used to calculate analytical concentration on a dry weight basis. Methods for the Chemical Analysis of Water and Wastes, Office of R&D, USEPA-EMSL, Cincinnati, OH, USEPA 600/4-79-020. Method 160.3. For Geochemical Characteristics ASTM Method D2216-80 will be used with a standard drying temperature of 110°C.

Total Organic Carbon (TOC) - Following acidification, the sample is purged with nitrogen to remove inorganic carbon. Persulfate is injected to oxidize organic carbon to carbon dioxide which is detected by IR. An OI Model 700 TOC Analyzer is used. Method 9060.

Alkalinity - Alkalinity is the measure of the capacity of the water to accept protons. It is determined by titrating the sample with standardized sulfuric acid. Titration is continued past the phenolphthalein alkalinity endpoint at pH of 8.3 to a pH of 4.5 for the total alkalinity. Solid wastes can be analyzed by analyzing a slurry prepared with deionized water. Methods for the Chemical Analysis of Water and Wastes, USEPA 600/4-79-020. Method 310.1.

Total Dissolved Solids - A well-mixed sample is filtered through a glass fiber filter. The filtrate is collected in a tared beaker and dried to a constant weight at 180°C. The increase in weight is the Total Dissolved Solids. Methods for Chemical Analysis of Water and Wastes, USEPA 600/4-79-020. Method 160.1.

Hardness - A buffer solution is used to bring the pH of a sample to approximately 10. As Eriochrome Black T indicator is added, the sample turns red. EDTA is then added as a titrant, calcium and magnesium ions are chelated, and the samples turns from red to blue at the endpoint. Large concentrations of heavy metals can interfere with the endpoint but can be overcome by the addition of an inhibitor. Methods for the Chemical Analysis of Water and Wastes, USEPA 600/4-79-020, Method 130.2.

pH - A 1:1 slurry of the solid and deionized water is made. The slurry is tumbled for 30 minutes and allowed to settle for about an hour. The activity of hydrogen ions in the supernatant is measured using a glass electrode and a reference electrode. Method 9045A.

Cation Exchange Capacity - This method determines the cation-exchange capacity of soils. The soil is mixed with an excess of 1 N ammonium acetate solution. This results in an exchange of the ammonium cations for exchangeable cations present in the soil. The excess ammonium is removed, and the amount of exchangeable ammonium is determined by titration. Method 9080.

Grain Size - This method determines grain size distribution through the use of a series of sieves of requires mesh size and a sedimentation process using a hydrometer. ASTM D421-85/ASTM D422-63 (90).

Inorganic Method Numbers					
	ICP	GFAA	Flame AA	Hydride AA	Cold Vapor
Aluminum	6010A		7020		
Antimony	6010A		7040		
Arsenic	6010A	7060		7061A	
Barium	6010A		7080		
Beryllium	6010A		7090		
Cadmium	6010A		7130		
Calcium	6010A		7140		
Chromium	6010A		7190		
Cobalt	6010A		7200		
Copper	6010A		7210		
Iron	6010A		7380		
Lead	6010A	7421	7420		
Magnesium	6010A		7450		
Manganese	6010A		7460		
Mercury					7470/ 7471
Nickel	6010A		7520		
Potassium	6010A		7610		
Selenium	6010A	7740		7741	
Silver	6010A		7760		
Sodium	6010A		7770		
Thallium	6010A	7841	7840		
Vanadium	6010A		7910		
Zinc	6010A		7950		

The number of Parameters analyzed and the method used will be determined by the site-specific requirements. For this project ICP, GFAA, and Cold Vapor methods will be used.

TCL Volatile Compounds by 8260 (GC/MS)				
Compound	Waters		Soils**	
	LOQ* (ug/l)	J-Value (ug/l)	LOQ* (ug/kg)	J-Value (ug/kg)
Chloromethane	10.	1.	10.	1.
Bromomethane	10.	1.	10.	1.
Vinyl chloride	10.	1.	10.	1.
Chloroethane	10.	1.	10.	1.
Methylene chloride	5.	1.	5.	1.
Acetone	100.	1.	100.	1.
Carbon Disulfide	100.	1.	100.	1.
1,1-Dichloroethene	5.	1.	5.	1.
1,1-Dichloroethane	5.	1.	5.	1.
1,2-Dichloroethene (Total)	5.	1.	5.	1.
Chloroform	5.	1.	5.	1.
1,2-Dichloroethane	5.	1.	5.	1.
2-Butanone	100.	1.	100.	1.
1,1,1-Trichloroethane	5.	1.	5.	1.
Carbon tetrachloride	5.	1.	5.	1.
Bromodichloromethane	5.	1.	5.	1.
1,1,2,2-Tetrachloroethane	5.	1.	5.	1.
1,2-Dichloropropane	5.	1.	5.	1.
trans-1,3-Dichloropropene	5.	1.	5.	1.
Trichloroethene	5.	1.	5.	1.
Dibromochloromethane	5.	1.	5.	1.
1,1,2-Trichloroethane	5.	1.	5.	1.
Benzene	5.	1.	5.	1.
cis-1,3-Dichloropropene	5.	1.	5.	1.
Bromoform	5.	1.	5.	1.
4-Methyl-2-pentanone	50.	1.	50.	1.
2-Hexanone	50.	1.	50.	1.

TCL Volatile Compounds by 8260 (GC/MS)				
Compound	Waters		Soils**	
	LOQ* (ug/l)	J-Value (ug/l)	LOQ* (ug/kg)	J-Value (ug/kg)
Tetrachloroethene	5.	1.	5.	1.
Toluene	5.	1.	5.	1.
Chlorobenzene	5.	1.	5.	1.
Ethylbenzene	5.	1.	5.	1.
Styrene	5.	1.	5.	1.
Xylene (total)	5.	1.	5.	1.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis will be higher.

The laboratory routinely reports at the limit of quantitation (LOQ) but can estimate down to the "J"-Value when requested by the client. Values reported below the LOQ are reported with a J-flag and are defined as estimated values.

TCL Semivolatile Compounds by 8270A				
Compound	Waters		Soils**	
	LOQ* (ug/l)	J-Value (ug/l)	LOQ* (ug/kg)	J-Value (ug/kg)
Acenaphthene	10.	1.	330.	30.
Acenaphthylene	10.	1.	330.	30.
Anthracene	10.	1.	330.	30.
Benzo (a) anthracene	10.	1.	330.	30.
Benzo (b) fluoranthene	10.	1.	330.	30.
Benzo (K) fluoranthene	10.	1.	330.	30.
Benzo (ghi) perylene	10.	1.	330.	30.
Benzo (a) pyrene	10.	1.	330.	30.
bis (2-Chloroethoxy) methane	10.	1.	330.	30.
bis (2-Chloroethyl) ether	10.	1.	330.	30.
bis (2-Ethylhexyl) phthalate	10.	1.	330.	30.
4-Bromophenyl phenyl ether	10.	1.	330.	30.
Butyl benzyl phthalate	10.	1.	330.	30.
Cabazole	10.	1.	330.	30.
4-Chloroaniline	10.	1.	330.	30.
4-Chloro-3-methylphenol	10.	1.	330.	30.
2-Chloronaphthalene	10.	1.	330.	30.
2-Chlorophenol	10.	1.	330.	30.
4-Chlorophenyl phenyl ether	10.	1.	330.	30.
Chrysene	10.	1.	330.	30.
2-methyl phenol	10.	1.	330.	30.
3 and 4 methyl phenol	10.	1.	330.	30.
Dibenzofuran	10.	1.	330.	30.
Di-n-butyl phthalate	10.	1.	330.	30.
Dibenz (a,h) anthracene	10.	1.	330.	30.

TCL Semivolatile Compounds by 8270A				
Compound	Waters		Soils**	
	LOQ* (ug/l)	J-Value (ug/l)	LOQ* (ug/kg)	J-Value (ug/kg)
1,2-Dichlorobenzene	10.	1.	330.	30.
1,3-Dichlorobenzene	10.	1.	330.	30.
1,4-Dichlorobenzene	10.	1.	330.	30.
3,3'-Dichlorobenzidine	20.	1.	670.	30.
2,4-Dichlorophenol	10.	1.	330.	30.
Diethyl phthalate	10.	1.	330.	30.
2,4-Dimethylphenol	10.	1.	330.	30.
Dimethyl phthalate	10.	1.	330.	30.
2-Methyl-4,6-dinitrophenol	25.	1.	830.	30.
2,4-Dinitrophenol	25.	1.	830.	30.
2,4-Dinitrotoluene	10.	1.	330.	30.
2,6-Dinitrotoluene	10.	1.	330.	30.
Di-n-octyl phthalate	10.	1.	330.	30.
Fluoranthene	10.	1.	330.	30.
Fluorene	10.	1.	330.	30.
Hexachlorobenzene	10.	1.	330.	30.
Hexachlorobutadiene	10.	1.	330.	30.
Hexachlorocyclopentadiene	10.	1.	330.	30.
Hexachloroethane	10.	1.	330.	30.
Indeno (1,2,3-cd) pyrene	10.	1.	330.	30.
Isophorone	10.	1.	330.	30.
Methylnaphthalene	10.	1.	330.	30.
Naphthalene	10.	1.	330.	30.
2-Nitroaniline	10.	1.	330.	30.
3-Nitroaniline	10.	1.	330.	30.
4-Nitroaniline	10.	1.	330.	30.
Nitrobenzene	10.	1.	330.	30.

TCL Semivolatile Compounds by 8270A				
Compound	Waters		Soils**	
	LOQ* (ug/l)	J-Value (ug/l)	LOQ* (ug/kg)	J-Value (ug/kg)
2-Nitrophenol	10.	1.	330.	30.
4-Nitrophenol	25.	1.	830.	30.
N-Nitrosodiphenylamine	10.	1.	330.	30.
N-Nitrosodi-n-propylamine	10.	1.	330.	30.
2,2'-Oxybis(1-chloropropane)	10.	1.	330.	30.
Pentachlorophenol	25.	1.	830.	30.
Phenanthrene	10.	1.	330.	30.
Phenol	10.	1.	330.	30.
Pyrene	10.	1.	330.	30.
1,2,4-Trichlorobenzene	10.	1.	330.	30.
2,4,5-Trichlorophenol	10.	1.	330.	30.
2,4,6-Trichlorophenol	10.	1.	330.	30.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis will be higher.

The laboratory routinely reports at the limit of quantitation (LOQ) but can estimate down to the "J"-Value when requested by the client. Values reported below the LOQ are reported with a J-flag and are defined as estimated values.

TCL Pesticide/PCB Compounds by 8080				
Compound	Waters		Soils**	
	LOQ* (ug/l)	J-Value (ug/l)	LOQ* (mg/kg)	J-Value (mg/kg)
Aldrin	0.01	.005	0.01	.004
alpha-BHC	0.01	.005	0.01	.004
beta-BHC	0.01	.005	0.01	.006
delta-BHC	0.01	.005	0.01	.003
gamma-BHC (Lindane)	0.01	.005	0.01	.003
alpha-Chlordane	0.05	.01	.05	.01
gamma-Chlordane	0.05	.01	.05	.01
4,4-DDT	0.01	.005	0.01	.006
4,4-DDE	0.01	.005	0.01	.003
4,4-DDD	0.01	.005	0.01	.004
Dieldrin	0.01	.002	0.01	.004
Endosulfan I	0.01	.002	0.01	.005
Endosulfan II	0.01	.005	0.01	.006
Endosulfan sulfate	0.03	.01	0.03	.006
Endrin	0.01	.005	0.01	.005
Endrin aldehyde	0.1	.05	0.1	.018
Endrin ketone	.1	.02	0.1	.02
Heptachlor	0.01	.005	0.01	.003
Heptachlor epoxide	0.01	.005	0.01	.005
Methoxychlor	0.05	.025	0.05	.02
PCB-1016	1.	.2	0.2	.05
PCB-1221	1.	.2	0.2	.05
PCB-1232	1.	.2	0.2	.05
PCB-1242	1.	.2	0.2	.05
PCB-1248	1.	.2	0.2	.05
PCB-1254	1.	.2	0.2	.05
PCB-1260	1.	.2	0.2	.05
Toxaphene	4.	.4	2.	.5

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis will be higher.

The laboratory routinely reports at the limit of quantitation (LOQ) but can estimate down to the "J"-Value when requested by the client. Values reported below the LOQ are reported with a J-flag and are defined as estimated values.

TAL Compound List by SW846				
Analyte	Waters		Soils**	
	LOQ* (mg/l)	J-Value (mg/l)	LOQ* (mg/kg)	J-Value (mg/kg)
Aluminum	.2	.06	60.	20.
Antimony	.2	.03	40.	4.
Arsenic[1]	.005	.001	2.	.4
Barium	.1	.003	20.	.2
Beryllium	.01	.001	1.	.3
Cadmium	.01	.003	4.	1.
Calcium	.2	.04	60.	20.
Chromium	.05	.005	8.	2.
Cobalt	.05	.006	10.	2.
Copper	.02	.003	8.	2.
Iron	.1	.03	20.	4.
Lead	.1	.03	20.	4.
Magnesium	.1	.03	30.	8.
Manganese	.01	.002	4.	1.
Mercury[2]	.0002	.00006	.3	.07
Nickel	.05	.006	10.	3.
Potassium	.5	.1	100.	30.
Selenium[1]	.003	.0007	2.	.6
Silver	.02	.006	4.	1.
Sodium	.4	.1	200.	20.
Thallium	.3	.08	100.	30.
Vanadium	.01	.003	4.	1.
Zinc	.04	.009	40.	9.
Cyanide	.005	.001	0.1	.005

[1] Analysis by Graphite Furnace

[2] Analysis by Cold Vapor

Except for cyanide, all other elements analyzed by ICP.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis will be higher.

The laboratory routinely reports at the limit of quantitation (LOQ) but can estimate down to the "J"-Value when requested by the client. Values reported below the LOQ are reported with a J-flag and are defined as estimated values.

Parameter	Waters		Soils**	
	LOQ* (mg/l)	J-Value (mg/l)	LOQ* (mg/kg)	J-Value (mg/kg)
TOC	0.5	.04	50.	1.0
Alkalinity	1.0	.5	NA	NA
TDS	25.0	8.5	NA	NA
Hardness	1.0	.3	NA	NA
pH	.01 units	NA	.01 units	NA
Moisture	NA	NA	.5	.1

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis will be higher.

The laboratory routinely reports at the limit of quantitation (LOQ) but can estimate down to the "J"-Value when requested by the client. Values reported below the LOQ are reported with a J-flag and are defined as estimated values.

10. Data Reduction, Validation and Reporting

Raw analytical data generated in the laboratories is collected on printouts from the instruments and associated data system or manually in bound notebooks. Analysts review data as it is generated to determine that the instruments are performing within specifications. This review includes calibration checks, surrogate recoveries, blank checks, retention time reproducibility, and other QC checks described in Section No. 11. If any problems are noted during the analytical run, corrective action is taken and documented.

Each analytical run is reviewed by a chemist for completeness and accuracy prior to interpretation and data reduction. The following calculations are used to reduce raw data to reportable results.

GC/MS calculation used by the data system to determine concentration in extract for semivolatiles or in the sample itself for volatiles:

$$Q = (Ax)\ (Is)\ /\ (AIs)\ (RRF)\ (Vi)$$

Where Ax = peak area

AIs = internal standard peak area

Is = amount of internal standard injected (ng)

RRF = relative response factor

Vi = volume of extract injected (ul) or volume sample purged (ml)

The extract concentration is further reduced by considering the initial sample weight or volume and the final extract volume:

$$Concentration = (Q)\ (D)\ (F)\ (1000)\ /\ (I)$$

Where Q = concentration determined by the data system (mg/l)

D = dilution factor if needed

F = final extract volume (ml)

I = initial sample weight (grams) or volume (ml)

Results are reported in ug/l for water samples and ug/kg for solid samples. Soil samples are reported on an as received and on a dry weight basis. The results are reported on Analysis Report Forms shown in Appendix A.

The results for the Pesticides/PCB's analysis are calculated using the following equation:

$$Concentration = (Ax)\ (Is)\ (Vt)\ (DF)\ /\ (As)\ (Vi)\ (Vs)$$

Where Ax = peak height for the parameter being measured

Is = amount of standard injected (ng)

Vt = volume of total extract (ul)

DF = dilution factor, if needed

As = peak height for the external standard

Vi = volume of extract injected (ul)

Vs = volume (ml) or weight (gm) of sample extracted

Results are reported as ug/l for water samples and mg/kg for solid samples. Soil samples are reported on an as received and on a dry weight basis. Results are reported on Analysis Report Forms shown in Appendix A.

The results for inorganic analyses are calculated using the following equation:

$$Concentration = (A)\ (D)\ (E)\ /\ (F)$$

Where A = the concentration determined by AA, ICP, or FTIR using calibration data programmed into the instrument (mg/l)

D = dilution factor if needed

E = final extract volume (ml)

F = initial sample volume (ml) or weight (gm)

Results are usually reported in mg/l for water samples and in mg/kg for solid samples. Alternate units are available upon request. Soil samples are reported on an as received and on a dry weight basis. The results are reported on Analysis Report Forms shown in Appendix A.

The results for alkalinity are calculated using the following equation:

$$Alkalinity,\ mg/l\ CaCO_3 = \frac{ml\ of\ titrant \times Normality \times 50{,}000}{ml\ of\ sample}$$

Results are reported in mg/l for water samples. The results are reported on Analysis Report Forms shown in Appendix A.

The results for hardness are calculated using the following equation:

$$EDTA\ Constant = 10\ ml\ CaCO_3\ /\ ml\ of\ titrant$$

$$Hardness\ (mg/l\ as\ CaCO_3) = \frac{A \times N \times 1000}{ml\ sample}$$

Where A = ml EDTA titrant
N = EDTA Constant

Results are reported in mg/l for water samples. The results are reported on Analysis Report Forms shown in Appendix A.

Total dissolved solids are calculated using the following equation:

$$mg\ total\ dissolved\ solids/l = \frac{(A - B) \times 1000 \times 1000}{sample\ volume,\ ml}$$

Where A = Weight of dried residue and beaker or dish, g
B = Weight of beaker or dish, g

Percent Moisture:

$$\%\ Moisture = \frac{A - B}{C} \times 100$$

Where A = Weight of sample and container before drying
B = Weight of sample and container after drying
C = Weight of sample before drying

The principle criteria used to validate data will be the acceptance criteria described in Sections No. 8 and 11 and protocols specified in laboratory SOPs. Following review, interpretation and data reduction by the analyst, data is transferred to the laboratory sample management system

either by direct data upload from the analytical data system or manually. This system stores client information, sample results, and QC results. A security system is in place to control access of laboratory personnel and to provide an audit trail for information changes. The data is again reviewed by the Group Leader or another analyst whose function is to provide an independent review and verified on the sample management system. The person performing the verification step reviews all data including quality control information prior to verifying the data. Any errors identified and corrected during the review process are documented and addressed with appropriate personnel to ensure generation of quality data. If data package deliverables have been requested, the laboratory will complete the appropriate forms (see Appendix A) summarizing the quality control information, and transfer copies of all raw data (instrument print-outs, spectra, chromatograms, laboratory notebooks, etc.) to the Data Packages Group. This group will combine the information from the various analytical groups and the analytical reports from the laboratory sample management system into one package in the client requested format. This package is reviewed by the Quality Assurance Department for conformance with SOPs and to ensure that all QC goals have been met. Any analytical problems are discussed in the case narrative, which is also included with the data package deliverables.

The validation of the data by the Quality Assurance Department includes spot checking raw data versus the final report, checking that all pertinent raw data is included and does refer to the samples analyzed, review of all QC results for conformance with the method, and review of the case narrative for description of any unusual occurrences during analysis. This validation is performed using techniques similar to those used by the Sample Management Office for the USEPA's Contract Laboratory Program. The validation

performed by the laboratory does not address useability of the data, which usually requires some knowledge of the site. The laboratory will make every attempt to meet the requirements of this QAPP, thus reducing the need to assess useability of the data.

The laboratory sample management system is programmed to accept and track the results of quality control samples including blanks, surrogates, recoveries, duplicates, controls, and reference materials. The computer is programmed with the acceptance criteria for each type of QC sample and will display an out-of-spec message if the data is not within specifications. All data outside of specifications appears on a report to the Quality Assurance Department on the next working day. These are reviewed by the Quality Assurance Department for severity of the problems and trends in the data. The reports are then sent to the analytical groups for the purpose of documenting the corrective action taken. The sample management system also produces control charts and has searching capabilities to aid in data review. The flow of data from the time the samples enter the laboratory until the data is reported are summarized in Table 10-1.

Any data recorded manually will be collected in bound notebooks. All entries will be in ink, with no erasures or white-out being permitted. Any changes in data will be made using a single line to avoid obliteration of the original entry and will be dated and signed. Any data resulting from instrument printouts will be dated and will contain the signature and/or identification of the analyst responsible for its generation. After copies of the data are incorporated into the data package deliverables, the originals will be stored in locked archives at the laboratory for a period of ten years.

Project files will be created per client/project and will contain chain-of-custody records, analysis requirements, and laboratory acknowledgements which document samples received, laboratory sample number assignment, and analysis requested. Raw data is filed per batch number assignment and laboratory sample number which correlates to the sample receipt documents. When the project is complete, all documentation is archived in a limited access area and retained for ten years.

Table 10-1

Sample and Data Routing at Lancaster Laboratories, Inc.

Action	Personnel Involved
Sample received at LLI	Sample Administration
Sample is entered onto sample management system (lab ID number assigned, analyses scheduled, chain of custody started, storage location assigned)	Sample Administration
Sample stored in assigned location (refrigerator, freezer, etc.)	Sample Support
Acknowledgement sent to client	Sample Administration
Removed from storage for analysis; necessary aliquot taken and sample returned to storage	Technical Personnel
Analysis is performed according to selected analytical method; raw data recorded, reviewed, and transferred to computer by chemist or technician*	Technical Personnel
Computer performs calculations as programmed according to methods	Data Processing
Chemist or supervisor verifies raw data	Technical Personnel
Data package deliverables are assembled	Data Package Group
Data packages are reviewed prior to mailing	Quality Assurance Dept. Laboratory Management

* Analyses requiring the chemist's interpretation may involve manual data reduction prior to entry onto the computer.

11. Internal Quality Control Checks

The particular types and frequencies of quality control checks analyzed with each sample are defined in USEPA SW846 3rd Edition, 1986, Update 1, July 1992, and Chemical Analysis of Water and Wastes. The quality control checks routinely performed during sample analysis include surrogates, matrix spikes, duplicates, blanks, internal standards, and laboratory control samples. In addition to these checks, some inorganic analyses employ serial dilutions and interference check samples.

Surrogates (used for organic analysis only) - Each sample, matrix spike, matrix spike duplicate, and blank are spiked with surrogate compounds prior to purging and extraction in order to monitor preparation and analysis. Surrogates are used to evaluate analytical efficiency by measuring recovery.

Matrix Spikes - A matrix (soil or water) is spiked with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.

Duplicates (matrix spike duplicate - organics and inorganic hydride generation; duplicate - inorganics) - A second aliquot of a matrix/sample is analyzed at the same time as the original sample in order to determine the precision of the method. Recovery of the original compared to the duplicate is expressed as relative percent differences (RPD).

Blanks (Method, Preparation) - Blanks are an analytical control consisting of a volume of deionized, distilled laboratory water for water samples, or a purified solid

matrix for soil/sediment samples. (Metals use a digested reagent blank with soils.) They are treated with the same reagents, internal standards, and surrogate standards and carried through the entire analytical procedure. The blank is used to define the level of laboratory background contamination.

Internal Standards (used for GC/MS analysis) - Internal standards are compounds added to every standard, blank matrix, spike, matrix spike duplicate, and sample at a known concentration, prior to analysis. Comparison of the peak areas of the internal standards are used for internal standard quantitation as well as to determine when changes in the instrument response will adversely affect quantification of target compounds.

Serial Dilutions (used for inorganics ICP only) - If the analyte concentration is sufficiently high ($\geq$50 x IDL) an analysis of a 5 fold dilution must agree within 10% of the original determination. If the dilution analysis is not within 10%, a chemical or physical interference effect should be suspected.

Interference Check Sample (ICP) - To verify interelement and background correction factors a solution containing both interfering and analyte elements of known concentration is analyzed at the beginning and end of each analysis run or a minimum of twice per 8 hours.

Laboratory Control Samples - Aqueous and solid control samples of known composition are analyzed using the same sample preparation, reagents, and analytical methods employed for the sample. For inorganics, LCS recovery must fall within established control limits. For organics, an LCS is run when MS/MSD recovery falls outside established

limits. The LCS recovery must fall within acceptance limits based on statistical evaluation of past lab data.

The results of all quality control samples are entered into the computer along with sample results. The computer is programmed to compare the individual values with the acceptance limits. If the results are not within the acceptance criteria, appropriate corrective action is taken where necessary. Management is kept informed by daily reports of QC outliers generated by the computerized system. Monthly reports on results of all QC analyses showing mean and standard deviation will indicate trends or method bias. Control Charts are plotted via computer and may be accessed at any time by all analysts.

The charts that follow show the types and frequency of QC performed, along with the acceptance limits and corrective action.

Table 11-1

Quality Control
GC/MS Volatiles

Type	Acceptance Limits(%) WATERS	SOILS	Frequency	Corrective Action
Surrogates: Toluene-d8 Bromofluorobenzene Dibromofluoromethane	 88-110 86-115 86-118	 81-117 74-121 80-120	Each sample, MS, MSD, LCS, and blank	Re-analyze sample if outside limits. If re-analysis confirms original, document on report and/or case narrative
Matrix Spikes: Spike all compounds of interest	 17-212*	 17-212*	Each group (≤20) of samples per matrix/level	LCS run for compounds outside recovery window
Laboratory Control Samples: Spike all compounds of interest	Same as for matrix spikes		Each group (≤20) When MS/MSD falls outside established limits	Re-analyze LCS and associated samples for compounds outside window
Matrix Spike Duplicates (RPD): Spike all compounds of interest	≤30%		Each group (≤20) of samples per matrix/level	Evaluated by analyst in relationship to other QC results
Blanks:	≤(5X) LOQ For: methylene chloride acetone toluene 2-butanone ≤LOQ for all other compounds		Once for each 12-hour time period	Re-analyze blank and associated samples if blank outside limits

Table 11-1

Quality Control
GC/MS Volatiles

Type	Acceptance Limits(%) WATERS	SOILS	Frequency	Corrective Action
Internal Standards: 1,4-dichlorobenzene-d4 1,4-Difluorobenzene Chlorobenzene-d5 1,2-Dichloroethane-d4	-50% to +100% of internal standard area of 12-hour STD RT Change $\leq$ 30 sec.		Each sample, MS, MSD, LCS, and blank	Re-analyze samples. If re-analysis confirms original, document on report or case narrative

*When sufficient data points are acquired (minimum of 30) statistical acceptance limits will be established

Accuracy is subject to change over time.

Table 11-2

Quality Control
GC/MS Semivolatiles

Type	Acceptance Limits (%) WATERS	SOILS	Frequency	Corrective Action
Surrogate:			Each sample, MS, MSD, LCS, and blank	Repeat analysis if more then one surrogate out per fraction (acid/base) or any recovery <10%. If reanalysis confirms originals, document on report and/or case narrative
Nitrobenzene-d5	35-114	23-120		
2-Fluorobiphenyl	43-116	30-115		
Terphenyl-d14	33-141	18-137		
Phenol-d6	10- 94	24-113		
2-Fluorophenol	21-100	25-121		
2,4,6-Tribromophenol	10-123	19-122		
Matrix Spikes: Spike all compounds of interest	See Table 11-3 for acceptance limits		Each group (≤20) of samples per matrix/level	Run LCS for compounds outside recovery window
Laboratory Control Sample: Spike all compounds of interest	Same as for spikes		Each group (≤20) When MS/MSD falls outside established limits.	Re-extract and re-analyze LCS and associated samples for compounds outside acceptance limits
Matrix Spike Duplicates (RPD): Same as for matrix spikes	≤ 30%		Each group (≤20) of samples per matrix/level	Evaluated by analyst in relationship to other QC results
Blanks:	≤ (5x) LOQ for the phthalate esters and benzaldehyde ≤ LOQ for all other compounds		Once per case or group (≤20) of samples, each matrix, level, instrument	Re-extract and re-analyze blank and associated samples

Table 11-2

Quality Control
GC/MS Semivolatiles

Type	Acceptance Limits (%) WATERS	SOILS	Frequency	Corrective Action
Internal Standards: 1,4-Dichlorobenzene-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	-50 to +100 of internal standard area of 12 hour STD RT change ≤30 sec.		Each sample, MS, MSD, LCS, and blank	Re-analyze samples. If re-analysis confirms original, document on report and/or case narrative

Accuracy is subject to change over time.

Table 11-3

TCL Semivolatile Matrix Spike/ Matrix Spike Duplicate Sample Recovery

Compound Name	Acceptance Limits (%)
Phenol	5.0 - 112.0
bis (2-Chloroethyl) ether	12.0 - 158.0
2-Chlorophenol	23.0 - 134.0
1,3-Dichlorobenzene	1.0 - 172.0
1,4-Dichlorobenzene	20.0 - 124.0
1,2-Dichlorobenzene	32.0 - 129.0
bis (2-Chloroisopropyl) ether	36.0 - 166.0
N-Nitroso-di-n-propylamine	1.0 - 230.0
Hexachloroethane	40.0 - 113.0
Nitrobenzene	35.0 - 180.0
Isophorone	21.0 - 196.0
2-Nitrophenol	29.0 - 182.0
2,4-Dimethylphenol	32.0 - 119.0
bis (2-Chloroethoxy) methane	33.0 - 184.0
2,4-Dichlorophenol	39.0 - 135.0
1,2,4-Trichlorobenzene	44.0 - 142.0
Naphthalane	21.0 - 133.0
Hexachlorobutadiene	24.0 - 116.0
4-Chloro-3-methylphenol	22.0 - 147.0
Hexachlorocyclopentadiene	1.0 - 100.0
2,4,6-Trichlorophenol	37.0 - 144.0
2-Chloronaphthalene	60.0 - 118.0
Dimethylphthalate	1.0 - 112.0
Acenaphthylene	33.0 - 145.0
Acenaphthene	47.0 - 145.0
2,4-Dinitrophenol	1.0 - 191.0
4-Nitrophenol	1.0 - 132.0

Table 11-3

**TCL Semivolatile Matrix Spike/
Matrix Spike Duplicate Sample Recovery**

Compound Name	Acceptance Limits (%)
2,4-Dinitrotoluene	39.0 - 139.0
Diethylphthalate	1.0 - 114.0
4-Chlorophenyl-phenylether	25.0 - 158.0
Fluorene	59.0 - 121.0
4,6-Dinitro-2-methylphenol	1.0 - 181.0
N-Nitrosodiphenylamine	37.8 - 147.0
4-Bromophenyl-phenylether	53.0 - 127.0
Hexachlorobenzene	1.0 - 152.0
Pentachlorophenol	14.0 - 176.0
Phenanthrene	54.0 - 120.0
Anthracene	27.0 - 133.0
Di-n-butylphthalate	1.0 - 118.0
Fluoranthene	26.0 - 137.0
Pyrene	52.0 - 115.0
Butylbenzylphthalate	1.0 - 152.0
3,3'-Dichlorobenzidine	1.0 - 262.0
Benzo(a)anthracene	33.0 - 143.0
Chrysene	17.0 - 168.0
bis(2-Ethylhexyl)phthalate	8.0 - 158.0
Di-n-octylphthalate	4.0 - 146.0
Benzo(b)fluoranthene	24.0 - 159.0
Benzo(k)fluoranthene	11.0 - 163.0
Benzo(a)pyrene	17.0 - 163.0
Indeno(1,2,3-cd)pyrene	1.0 - 171.0
Dibenz(a,h)anthracene	1.0 - 227.0
Benzo(g,h,i)perylene	1.0 - 219.0
Dibenzofuran	28.4 - 131.4

Table 11-3

**TCL Semivolatile Matrix Spike/
Matrix Spike Duplicate Sample Recovery**

Compound Name	Acceptance Limits (%)
4-Chloroaniline	17.4 - 116.0
2,4,5-Trichlorphenol	39.2 - 151.4
2-Nitroaniline	60.3 - 106.3
2-Methylphenol	45.9 - 122.5
4-Methylphenol	5.4 - 152.2
Benzyl Alcohol	65.9 - 100.0
2-Methyl Naphthalene	27.6 - 123.2
3-Nitroaniline	7 - 143
4-Nitroaniline	38 - 122
2,4-Dinitrotoluene	39 - 139

Acceptance limits are based on statistical evaluation of compiled laboratory data and are subject to change.

Table 11-4

Quality Control
Pesticides/PCBs

Type	Acceptance Limits (%) WATERS	SOILS	Frequency	Corrective Action
Surrogate: Organochlorine Pesticides; DBC TCMX	 60-120 60-120	 50-120 50-120	Added to each sample, MS/MSD, LCS, blank, LCS/LCSD during the extraction phase	At least one surrogate must be in spec unless matrix-related problems are evident. If matrix-related problems are evident, report results and comment in case narrative.
Matrix Spikes: Organochlorine Pesticides; Spike all compounds of interest, except PCBs, chlordanes, endrin ketone, and toxaphene PCBs Only; 1242 1260	 See attached Table 11-5 75-120 77-120	 69-115 71-119	Each group (≤20) of samples per matrix/level	Run LCS for compounds outside acceptance window

Table 11-4

Quality Control
Pesticides/PCBs

Type	Acceptance Limits (%) WATERS	SOILS	Frequency	Corrective Action
Laboratory Control Sample: Organochlorine Pesticides; Spike all compounds of interest, except PCBs, chlordanes, endrin ketone, and toxaphene	See attached Table 11-5		Each group (≤20) When MS/MSD falls outside established limits.	Re-extract and re-analyze LCS and associated samples for compounds outside acceptance limits
PCBs Only; 1242 1260	75-120 77-120	69-115 71-119		
Matrix Spike Duplicates (RPD): Organochlorine Pesticides; Spike all compounds of interest, except PCBs, chlordanes, endrin ketone, and toxaphene	Water ≤30% Soils ≤50%		Each group (≤20) of samples per matrix/level	Evaluated by analyst in relationship to other QC results
PCBs Only; 1242 1260				

Table 11-4

Quality Control
Pesticides/PCBs

Type	Acceptance Limits (%) WATERS	SOILS	Frequency	Corrective Action
Blanks:	≤LOQ for all compounds		Once per case or extraction group (≤20) of samples, each matrix, level, instrument	Inject a hexane or solvent blank first to be sure the analytical system is clean, then reinject the blank itself. If the reinjected blank is acceptable, any samples extracted with this blank should be reinjected if they, too, contain the analyte which was contaminating the blank. If the reinjected blank is unacceptable, any affected samples must be extracted.

Acceptance limits are based on statistical evaluation of compiled laboratory data and are subject to change.

Table 11-5

Quality Control
Pesticides/PCBs

Organochlorine Pesticides Spike Acceptance Limits

Compound Name	Matrix Spike and Laboratory Control Sample Limits for Waters (%)	Matrix Spike Limits for Soils (%)	Laboratory Control Limits for Soils (%)
Lindane	79-120	63-120	49-125
Heptachlor	64-120	45-120	48-120
Aldrin	59-120	62-120	50-125
DDT	74-120	59-121	29-134
Dieldrin	77-120	55-123	54-128
Endrin	73-120	64-124	55-129
Methoxychlor	76-120	39-129	24-128
Delta-BHC	62-120	68-110	57-110
Heptachlor Epoxide	80-120	71-126	52-136
Endosulfan I	72-110	57-120	55-120
Endrin Aldehyde	70-121	31-120	25-120
Alpha-BHC	69-120	59-120	45-122
Beta-BHC	72-115	66-120	45-131
DDE	69-105	63-120	42-129
DDD	71-115	65-120	43-126
Endosulfan II	76-120	64-120	47-122
Endosulfan sulfate	63-120	62-120	36-129

Acceptance limits are based on statistical evaluation of compiled laboratory data and are subject to change.

Table 11-6

Quality Control
Inorganics

Type	Acceptance Limits(%) WATERS SOILS	Frequency	Corrective Action
Matrix Spikes:	75-125% Except where sample conc. exceeds spike conc. by ≥4 x	Each group of samples of similar matrix/level (≤20) each method	Analyze post-digestion spike sample
Matrix Spike Duplicate (RPD):	75-125% Except where sample conc. exceeds spike conc. by ≥4 x ±20% RPD for sample values ≥5 x LOQ	Each group of samples of similar matrix/level (≤20) each method	Analyze post-digestion spike sample Flag the data
Duplicates (RPD):	±20% RPD for sample values ≥5 x LOQ	Each group of samples of similar matrix/level (≤20) each method	Flag the data

Table 11-6

Quality Control
Inorganics

Type	Acceptance Limits(%) WATERS	SOILS	Frequency	Corrective Action
Blanks:				
Initial Calibration (ICB) Continuing Calibration (CCB)	≤ LOQ		Each wavelength immediately after calibration verification at 10% frequency or every 2 hours (beginning and end of run min.)	Correct problem, recalibrate, and rerun
Preparation Blank	≤ LOQ > LOQ then lowest conc. in sample must be 10 x blk. conc.		Each SDG or batch (≤ 20 samples) Exception: As/Se by Hydride Generation ≤ 10 samples	Redigest and reanalyze blank and associated samples if sample result < 10 x blank result
Serial Dilutions:	Within ± 10% of the original determination		Each group of (≤20) of similar matrix/level	Flag the data

Table 11-6

Quality Control
Inorganics

Type	Acceptance Limits(%) WATERS	SOILS	Frequency	Corrective Action
Interference Check Sample:	± 20% of the true value for the analytes		Each wavelength after Initial Calibration Verification at beginning and end of the run or min. of 2x per 8 hour	Recalibrate the instrument
Laboratory Control Sample:	Aqueous 80-120% (except Ag and Sb) Solids commercial certified standard advisory range See Table 11-8		Each SDG or batch (≤ 20 samples), each method	Redigest and reanalyze LCS and associated samples
Post Digestion Spike:	85-115%		When matrix spikes are outside 75-125% range (not performed on GFAA analyses)	Flag the data
Analytical Spike:	85-115%		Every GFAA determination	See attached Flow Chart 7A

Table 11-7A

Figure 1.
FURNACE ATOMIC ABSORPTION ANALYSIS SCHEME

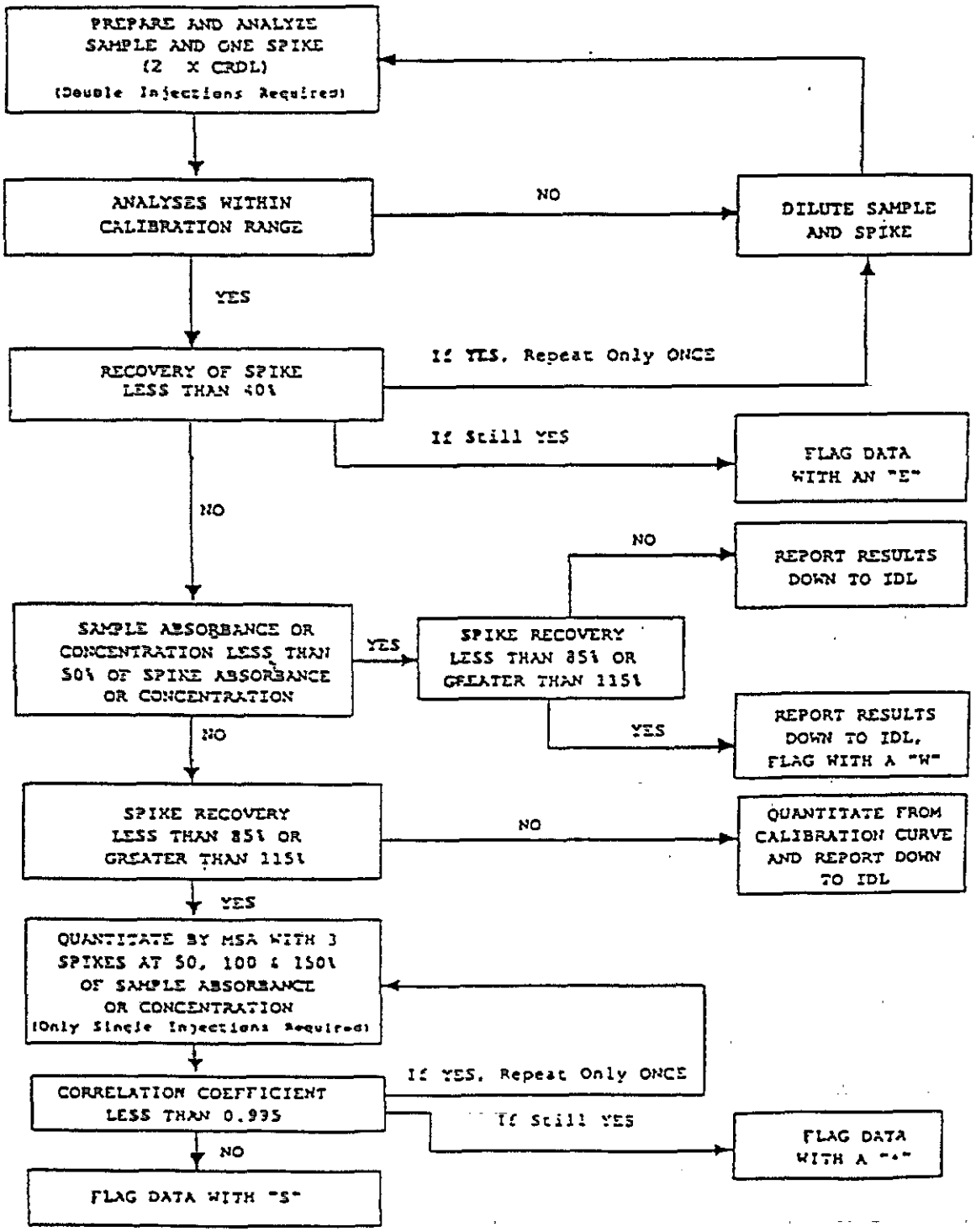

Table 11-8

ENVIRONMENTAL
RESOURCE ASSOCIATES
Arvada, Colorado 80002 1-800-ERA-0122

Certification

PriorityPollutnT™/CLP Quality Control Standards

Inorganics in Soil

Lot Number 216

Parameter	Certified Value mg/kg	Advisory Range mg/kg
TRACE METALS		
aluminum	5000	3500 - 6400
antimony	27.8	14 - 117
arsenic	67.7	41 - 105
barium	187	131 - 243
beryllium	57.5	35 - 81
cadmium	110	55 - 166
calcium	2040	1220 - 2860
chromium	169	95 - 265
cobalt	87.0	43 - 130
copper	141	84 - 200
iron	10800	7020 - 15100
lead	100	55 - 140
magnesium	2050	1200 - 3080
manganese	294	206 - 383
mercury	2.36	1.3 - 3.8
molybdenum	124	93 - 167
nickel	79.6	40 - 112
potassium	2130	1260 - 2770
selenium	99.1	54 - 149
silver	124	62 - 186
sodium	527	316 - 738
thallium	67.9	34 - 102
vanadium	84.8	59 - 115
zinc	197	98 - 260

1. The Trace Metals Certified Values are equal to the mean recoveries for each parameter as determined in an interlaboratory round robin study (3 laboratories, 10 to 24 data points per parameter). The standard was digested using Method 3050, SW-846 and the digest analyzed by ICP and atomic absorption spectroscopy.

2. The Advisory Ranges are listed as guidelines for acceptable recoveries given the limitations of the EPA methodologies commonly used to determine these parameters. The range closely approximates the 95% confidence interval for these parameters based upon experimental data from this lot, previous ERA lots and published USEPA data.

* Each lot of standards will have different certified values and the advisory range will be adjusted accordingly.

Table 11-9

Quality Control Acceptance Criteria

Parameter	Blank	Spike Recovery (%)	Duplicate RPD (%)	Lab Control Recovery (%)
TOC	<LOQ	75-125	≤20	80-120
Alkalinity	NA	75-125	≤20	80-120
TDS	<LOQ	75-125	≤20	80-120
Hardness	<LOQ	75-125	≤20	80-120
Moisture	NA	NA	≤20	80-120
pH	NA	NA	≤20	80-120
Cation Exchange	<LOQ	NA	NA	80-120

Corrective Action: If either the LCS or Blank are outside the criteria, the QC and associated samples will be reprepped and re-analyzed.

Maximum batch size is 20 field samples.

12. Performance and System Audits

System audits are conducted on each department at Lancaster Laboratories, Inc. (LLI) and Mountain States Analytical, Inc. (MSAI) by members of the Quality Assurance Department. The audits include checks on methodology, reagent preparation, equipment calibration and maintenance, quality control results, and training of personnel. The results of the audits and corrective action, where necessary, are communicated to laboratory personnel and management by means of a written report. Audits by outside organizations including clients, regulatory personnel, and the USEPA are permitted by arrangement with the Quality Assurance Department.

The Quality Assurance Department reviews summaries of the quality control data entered onto the computerized sample management system by analysts. Control charts and statistics are reviewed for trends which may indicate problems with the analytical data. In this way, small problems are identified before they have any significant impact on laboratory results.

Performance audits consist of both intralaboratory and interlaboratory check samples. Blind samples containing known amounts of target analytes are prepared by the Quality Assurance Department and submitted to the laboratories under fictitious client names. In addition, QC samples from commercial suppliers are analyzed quarterly to assess laboratory accuracy. LLI and MSAI also participate in a number of interlaboratory performance evaluation studies which involve analysis of samples with concentrations of analytes that are known to the sponsoring organization, but unknown to the laboratory. Inorganics, pesticide/herbicides, trihalomethanes, volatile organic compounds, semivolatile organic compounds, and traditional

wet chemistry analyses are analyzed by LLI for studies conducted by the USEPA and the New York Department of Health and by MSAI for studies conducted by the USEPA and Utah Department of Health. LLI has participated in the USEPA Contract Laboratory Program which provides laboratory analysis in support of the Superfund program. Part of maintaining this contract includes analysis of quarterly blind samples. Representative results from some of these studies are attached to this section.

PERFORMANCE EVALUATION REPORT DATE: 12/27/93

WATER POLLUTION STUDY NUMBER WP031

LANCASTER LABORATORIES
7176562301 / LANCASTER, PA / CDO

LABORATORY: PA009

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
TRACE METALS IN MICROGRAMS PER LITER:						
ALUMINUM	1	688.	681	550- 794	579- 755	ACCEPTABLE
	2	153.	140	107- 182	117- 173	ACCEPTABLE
ARSENIC	1	567.	492	408- 547	439- 565	CHECK FOR ERROR
	2	70.0	78.3	56.7- 92.9	61.2- 88.4	ACCEPTABLE
BERYLLIUM	1	462.	461	382- 533	401- 514	ACCEPTABLE
	2	240.	240	198- 278	208- 268	ACCEPTABLE
CADMIUM	1	172.	165	138- 198	145- 187	ACCEPTABLE
	2	64.5	61.0	50.8- 72.0	53.5- 69.4	ACCEPTABLE
COBALT	1	908.	880	775- 990	801- 958	ACCEPTABLE
	2	58.8	53.8	45.8- 61.9	47.5- 59.8	ACCEPTABLE
CHROMIUM	1	758.	730	608- 881	638- 813	ACCEPTABLE
	2	24.1	23.8	17.8- 29.0	18.9- 27.6	ACCEPTABLE
COPPER	1	598.	601	528- 657	541- 600	ACCEPTABLE
	2	16.5	18.7	13.6- 24.1	14.9- 22.8	ACCEPTABLE
IRON	1	55.7	58.0	43.5- 72.5	47.2- 68.8	ACCEPTABLE
	2	1160.	1100	950- 1270	991- 1230	ACCEPTABLE
MERCURY	1	9.89	9.38	7.31- 11.9	7.89- 11.3	ACCEPTABLE
	2	7.00	6.67	5.00- 8.48	5.84- 9.04	ACCEPTABLE
MANGANESE	1	618.	600	536- 660	551- 648	ACCEPTABLE
	2	75.5	73.5	64.0- 82.7	66.8- 80.8	ACCEPTABLE
NICKEL	1	901.	860	766- 952	789- 928	ACCEPTABLE
	2	358.	340	296- 393	307- 372	ACCEPTABLE
LEAD	1	1240.	1200	1060- 1350	1100- 1310	ACCEPTABLE
	2	767.	738	636- 833	661- 809	ACCEPTABLE

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.